The Wireless World

THE PRACTICAL RADIO JOURNAL

VOLUME XXXII

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The Question of Quality

Public Demonstrations Needed

A FEW months ago the Correspondence columns of *The Wireless World* provided the platform for a long and almost heated debate on the subject of frequency range and quality, the argument centring round the very vexed question of how far the frequency range must be extended before we can approach the ideal of faithful reproduction of the original transmission. Although from its very nature this discussion produced no positive conclusions, yet it was extremely interesting and informative, and must have opened the eyes of many readers to a better appreciation of the importance of frequency range in quality reproduction.

"Good Quality"

There is, however, another aspect of the question of quality which deserves much wider consideration than is given to it at present. No one will deny that electrical reproduction, both of broadcast transmissions and gramophone records, is capable of giving very satisfying results ; results which in some cases may not approach perfection but which, nevertheless, are entitled to be described as "good quality." But, if a committee of judges of good quality were to take upon itself the task of going round and listening to individual sets throughout the country, we are afraid that the proportion of reproductions which would be accepted as coming within the category of good quality would be comparatively small. After ten years of broadcasting this may seem to be an unkind and rather pessimistic opinion to express, but we cannot help feeling that such an opinion would not be found to be an exaggeration of the position.

There are several causes which contribute to this unfortunate state of affairs ; in very many instances the receivers in use are not themselves to blame ; they may be quite capable of a good performance, but are being used under unsatisfactory conditions. An even more likely explanation of poor quality is that the users of the apparatus themselves have never been aroused to a consciousness of the limitations of the reproductions they have become accustomed to listening to.

Comparison Needed

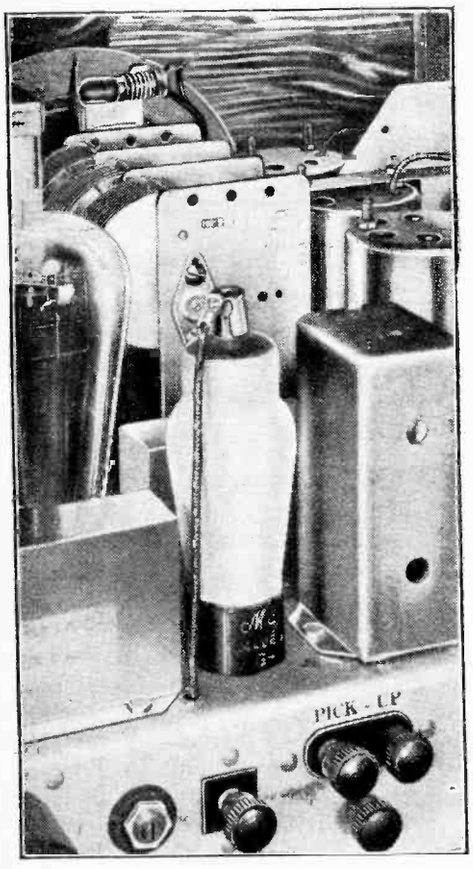
It is only by comparison that we can hope to bring about a general education of the public to an appreciation of a better standard. To achieve this result there appears to us to be only one straightforward method to adopt, and that is to give the public frequent opportunities for listening to the reproduction of really good quality, so that when next they switch on their own sets the feeling of dissatisfaction will be so great that something will be done about it.

As a start, we would like to see co-operative efforts made by the wireless industry aided, perhaps, financially by the B.B.C., to equip every railway station waiting room with a modest but good quality installation, and so facilitate the education of the public to a higher standard of quality reproduction. There are other convenient places where such an installation could be put up, but railway station waiting rooms would be a very good beginning because they are, on an average, of the same dimensions as living rooms at home, and, therefore, suitable for equipment with receivers the equivalent of those supplied for domestic use.

Practical Automatic Volume Control

The Application of Different Systems

By W. T. COCKING



Automatic volume control in a typical American design, showing the special 55 type valve developed in that country.

THE great disparity between the signal strengths of the numerous stations now available with selective receivers and the bugbear of fading have led to the development of systems whereby the sensitivity of the set is automatically controlled. In this article the two rival systems—the diode and the square law control—are discussed and the particular advantages of each are shown.

THE broad principles of automatic volume control have previously been explained in this journal,[1] and it may be said that such controls fall into two distinct classes—that in which a single detector valve is employed to provide both the L.F. signal and the automatic bias, and that in which two separate valves are used for the two functions. Each method has its own sphere of usefulness, and either may prove more convenient than the other under particular circumstances, for the choice of type of automatic volume control depends largely upon the design of the receiver.

The diode type of control, with which a single valve performs the two functions of providing the L.F. signal and of supplying the bias potentials, will be considered first, since it is the simpler to understand and to get into operation. As a concrete example, we will take a typical superheterodyne of modern design and suppose that it consists of a variable-mu H.F. stage, a screen-grid first detector, and a variable-mu I.F. stage, the volume control being a potentiometer controlling the bias of both variable-mu valves. The second detector will be of the power grid type, worked with a signal input of some 1 volt.

As the first step towards a conversion to A.V.C., let us replace the grid detector by a diode of the type shown in Fig. 1, and assume that the lead "A" is not connected and that the normal volume control is retained. The sensitivity of the set will immediately fall by the amount of amplification obtainable from a power grid detector; that is, it will fall to about one-twentieth to one-thirtieth of its normal value. It is obvious, therefore, that we shall have to add another stage of amplification to make up for the loss.

If the set were originally arranged so that the power grid detector fed the output stage directly, this extra amplification will usually be added in the form of an intermediate L.F. stage. Should the receiver already include such a stage, however, then it is probable that an additional I.F. valve would prove more satisfactory.

From our experience with the unmodified receiver, we know that the variable-mu valves are biased to about 5 volts for the reception of the stronger of distant stations, and that they need some 50 volts bias when the set is tuned to a strong local transmitter. With automatic control, the bias must be provided by the detector, and as a rough approximation we may assume that the bias voltage obtainable is equal to the detector input. It is immediately obvious that the control cannot keep volume constant. If a variation of bias between 5 and 50 volts be needed for certain stations, in order to provide this bias the detector input must vary between the same figures, which means that the sound output from the loud speaker will also vary. Actually, of course, the matter is to some extent relieved by the fact that working the detector at an abnormally high input means that less bias voltage will be required. In practice, therefore, the variation between a distant and local station might be between 5 and 30 volts instead of between 5 and 50 volts. The perfection of the action also depends upon the number of controlled stages, and the greater the number of controlled valves the more nearly perfect will be the results. It is usually desirable to control the first detector, therefore, as well as the amplifying stages, and so we can definitely settle upon employing a variable-mu valve at this point.

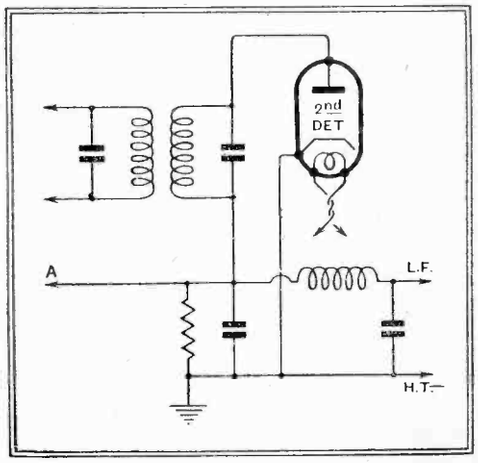


Fig. 1.—The diode detector provides one of the simplest types of A.V.C., for the bias may be tapped off from the point "A."

The I.F. Stage

The next point to consider is the stage immediately preceding the diode. As the detector may easily require an input of some 30 to 40 volts on a local station, the I.F. stage must be designed to give this output. An examination of valve curves reveals that a variable-mu type will not do this if it be biased negatively by more than about 3 volts. The normal bias for maximum sensitivity will be 1.5 volts, so that there is very little latitude for control in this stage, and in most cases we shall have to operate the valve with a fixed bias. Were two I.F. stages used, however, the control would be better, and the maximum detector input would be smaller, with the result that it might be possible to control the pre-detector stage. In general, full control is impossible with a diode A.V.C. system if distortion is to be avoided, and it is the common practice to feed back to it only a portion of the available bias voltage.

We are now in a position to sketch out the modified receiver, and this will take the form shown in Fig. 2. It will be seen that only the H.F. and the first detector valves are controlled, and that the

[1] Automatic Volume Control, *The Wireless World*, August 12th, 1932; Automatic Gain Control, *The Wireless World*, September 23rd and 30th, 1932.

Practical Automatic Volume Control—manual volume control takes the form of a potentiometer governing the input to the L.F. amplifier. The speed of operation of the control depends upon the values assigned to C and R, and, provided that their product remains constant, the actual values are unimportant.

The speed of control is important. If it be too slow the sensitivity of the set rises only slowly when tuning off a powerful station, and weak adjacent stations may be passed over. More important still, the sensitivity only decreases slowly on tuning in to a local station, so that momentary blasting may occur. If the operation be too fast, however, there is a possibility that the bias, and hence the amplification, may be affected by low notes in the desired transmission, and that distortion may thus appear.

In general, the optimum speed has been found to be about one-tenth to one-twentieth of a second. A speed of one-tenth of a second may be obtained by giving the condensers C, of Fig. 2, values of 0.1 mfd. when the resistances R are each of 1 megohm. The faster speed will be found with the same capacity condensers by using 0.5 megohm resistances. These components, as well as determining the time constant of the circuit, serve the purpose of decoupling the grid circuits of the controlled valves. The values adopted on the score of the time constant, however, provide very effective decoupling, so that this usually needs little consideration.

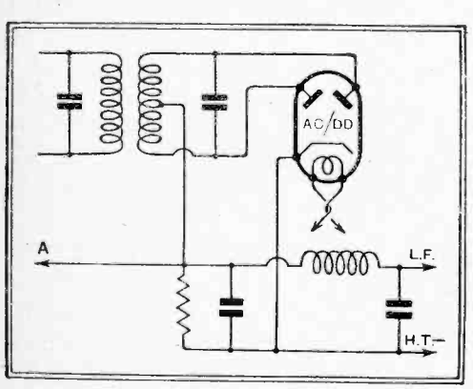


Fig. 3.—The practical circuit of a full-wave diode control differs from the simple type only in needing a centre-tapped secondary to the I.F. transformer.

The Double Diode

An arrangement of the type of Fig. 2 is capable of very good results, and there are several variations which can be introduced without affecting the general method of operation. Instead of the single diode shown, it is possible to employ a double diode, such as the Mazda AC/DD, and obtain full-wave rectification. The circuit of the detector portion is shown in Fig. 3, and it will be seen that the input is applied in push-pull to the diode. It is important that the inputs to the two halves be equal, otherwise the fundamental frequency of the H.F. output will not be balanced out, and it should be pointed out that the true electrical centre of the input coil may not be identical with the mechanical centre.

One of the disadvantages of all normal type diode A.V.C. systems is that they are always in operation. If it be desired to listen to a weak station, for which the full amplification of the set is needed, then less volume will be obtained from a set fitted with diode A.V.C. than from one with no such control. This is readily understandable when it is remembered that any signal on the detector, no matter how small, must result in some increase in bias to the early stages and some reduction of their amplification.

It is possible, however, to avoid this effect, and a simple method of doing this, which is particularly applicable with a valve such as the AC/DD, is shown in Fig. 4. It will be seen that one anode is connected normally to act as a diode, and the L.F. output from this circuit is fed to the L.F. amplifier in the usual way, no use being made of the D.C. potential developed across the load resistance. The other anode is fed in parallel through a condenser, but in this case the L.F. currents which appear as a result of the rectification in this circuit are not used, and the D.C. potential across the load is employed for the bias. At first sight there is little difference from the normal arrangement, and we are employing two anodes to do the work of one.

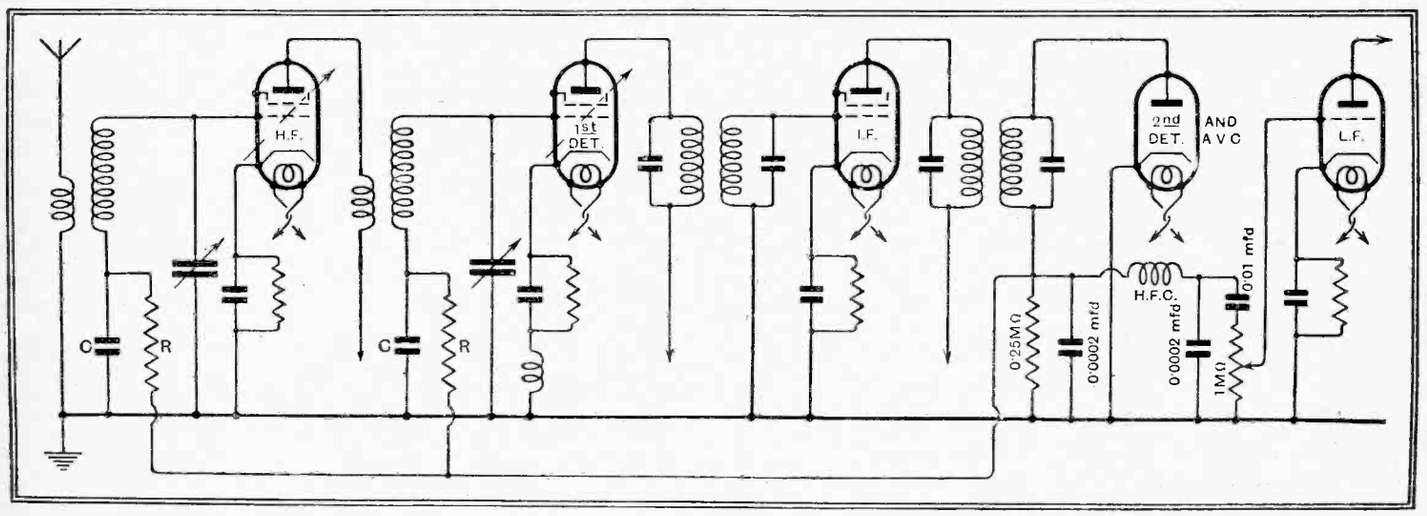
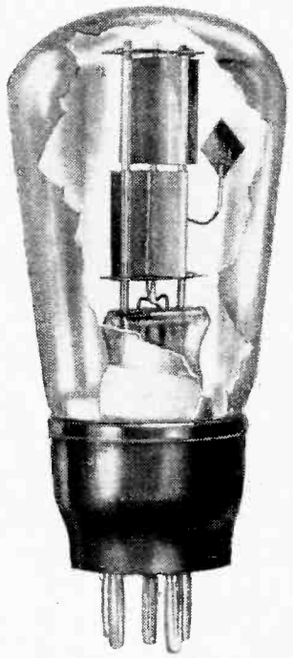


Fig. 2.—The application of a diode control to a modern superheterodyne. It should be noted that the I.F. valve is not controlled.



The Mazda AC/DD—the first British valve designed for full-wave detection and A.V.C. The bulb has been broken away to show the electrodes.

If we bias the A.V.C. anode negatively, however, there will be no rectification in this circuit until the signal input exceeds a certain value; but the other anode, not being biased, will always act normally. The result of this is that the automatic volume control will not be operative until the detector input exceeds a certain predetermined figure. The aforementioned disadvantage, therefore, can readily be overcome, and a diode control of this type need cause no loss of sensitivity on weak signals.

It will be obvious that there are many receivers to which the diode control is inapplicable. A diode must be used with a high load impedance, and this makes it difficult to obtain any high degree of tone correction in the coupling between the diode and the first L.F. stage. Tone correction, however, cannot be fitted in the coupling to the output stage, in most cases, if amplitude distortion in the preceding valve is to be avoided. Unless two L.F. stages are used as well as the output stage, therefore, tone correction with a diode detector becomes rather difficult.

It will be further apparent that a linear detector is not the best for the provision of the automatic bias voltages. If distortion is to be avoided, of course, a linear

Practical Automatic Volume Control

detector must be used for demodulation, but a square-law detector is greatly superior for automatic volume control. With a linear detector, such as the diode, doubling the detector input merely doubles the bias voltage, but with a square-law detector, doubling the input quadruples the bias, and a much more perfect control is possible. Moreover, the usual types of square-law detector operate with quite small input voltages, so that it becomes possible to control the last I.F. stage, and we get still a further gain.

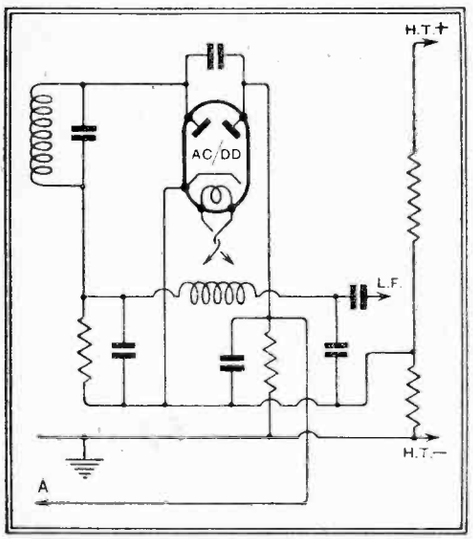


Fig. 4.—A method of diode control in which operation does not commence until the signal reaches a certain value.

A Comparison

This is well brought out by the curves of Fig. 5, which are calculated on the basis of a linear rectifier and two controlled stages for curve A and a square-law detector and three controlled stages for curve B. With the diode type of control the input can only vary 22 decibels for a 5 db change of output, whereas with a square-law detector and three controlled stages, the input can vary 65 db for the same change of output. Put into the more familiar voltage ratios, this means that if the detector input is not to rise to more than 1,778 times its normal value, the input to the set from the aerial must not rise more than 12.59 times with the diode control, whereas it can rise to 1,778 times with the square-law control.

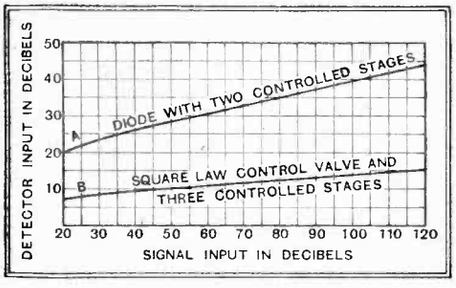


Fig. 5.—The above curves show the action of two types of control in a typical receiver. The superiority of the square-law type is evident.

It may be argued that this comparison is not quite fair to the diode, since with the square-law control there are also three controlled stages. It will be clear, however, that in the example chosen the comparison is a good one, for the possibility of using an extra controlled stage is one of the advantages to be derived from the employment of the low input square-law detector. In a receiver of different type, of course, the superiority might not be so marked, and there are undoubtedly cases where the diode is preferable, if only on account of its greater simplicity and the need for fewer components.

(To be concluded.)

DISTANT RECEPTION NOTES

As correspondents have pointed out recently in *The Wireless World*, interference from spark signals is still a great nuisance at times upon the medium waveband. The two worst patches are from 500 to 550 metres and from 200 to about 240 metres. Down near the bottom of the band the number of broadcasting stations that can be interfered with by even a single spark transmitter is large owing to the great spread of a transmission consisting of heavily damped waves when the parallel capacity in the tuned circuits of the receiving apparatus is reduced to a comparatively small amount.

Spark signals apart, there has been very little serious interference with distant transmissions. Atmospherics have never been more than intermittent background noises; few stations of importance have suffered from heterodynes, and fading has not been troublesome on wavelengths above 300 metres.

Best Stations To-day

Conditions have been almost ideal for reception of the long-wave stations, and these have come in well at all times. Motala is the only one of the long-wave stations that is not giving a first-rate account of itself so far as signal strength is concerned, though Oslo still suffers badly from heterodynes of Russian origin.

One of the best stations within the limits of the medium waveband is Katowice, which can now be relied upon at any time after about four o'clock. Bratislava and Bordeaux Lafayette are also outstanding amongst the less well-known stations.

Munich has shown considerable variations in its strength; one wonders if experiments are in progress with the new transmitter. Vienna has been generally good, and Florence is nearly always well received. Prague shows colossal strength, and Langenberg can be received at any time when it is working. Rome is generally good, but I do not find Stockholm so reliable. Madrid Union Radio is rather often interfered with, and strength is not so great as could be desired. Leipzig and Toulouse continue to furnish fine volume. Lwow is not quite at its best, but Brno is generally worth trying for.

Reliable Performers

The two Brussels stations never fail to oblige when called upon, and Strassbourg is giving excellent reception. Milan has nights when it is not up to the mark, but, as a rule, this station is well received. Poste Parisien and Breslau are both immensely strong, though Göteborg is not well received.

Genoa is sometimes good. Heilsberg, Turin and Frankfurt are all well heard, and Toulouse PTT often comes in well. When sparks are not troublesome Trieste, Nürnberg and Fécamp provide good volume. Valencia seems to be returning to strength once more, for loud speaker reception from this station has been possible on several recent evenings.

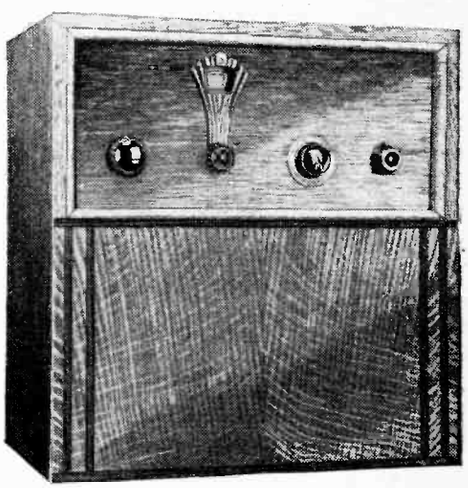
Transatlantic Reception

Conditions for transatlantic reception grow better and better. A good many people, I imagine, must hear American stations without realising that they are doing so, for there are several that can be picked up by 11 p.m. if the required dial settings are known. One of the most reliable for early reception is WCAU on 256.3 metres, and I have no doubt that this station is frequently mistaken for either Toulouse PTT or Hoerby. Similarly, WJJD on 265.4 metres may be mistaken for Lille. He uses exactly the same wavelength, and may be heard as soon as the French station closes down. I notice that one correspondent suggests that this station may not have been previously heard in this country. Actually, I have past records of reception from WJJD as well as recent ones. Other good Americans at the moment are WIOD, WHAM, WPG, KMOX, WTAM, WTIC, WBZ, KDKA, WENR, WGY, WJZ, WLW and WEAF.

D. EXER.

For the "Straight Three"

An attractive but quite inexpensive oak cabinet, specially designed for *The Wireless World* "Straight Three," has been submitted for approval by the Apollo Gramophone Co., Ltd., of 4-5, Bunhill Row, London, E.C.1. Ample space is provided for batteries, even of a larger size than are likely to be used with the set. A wooden "chassis," ready drilled, is included at the particularly low price of 18s.

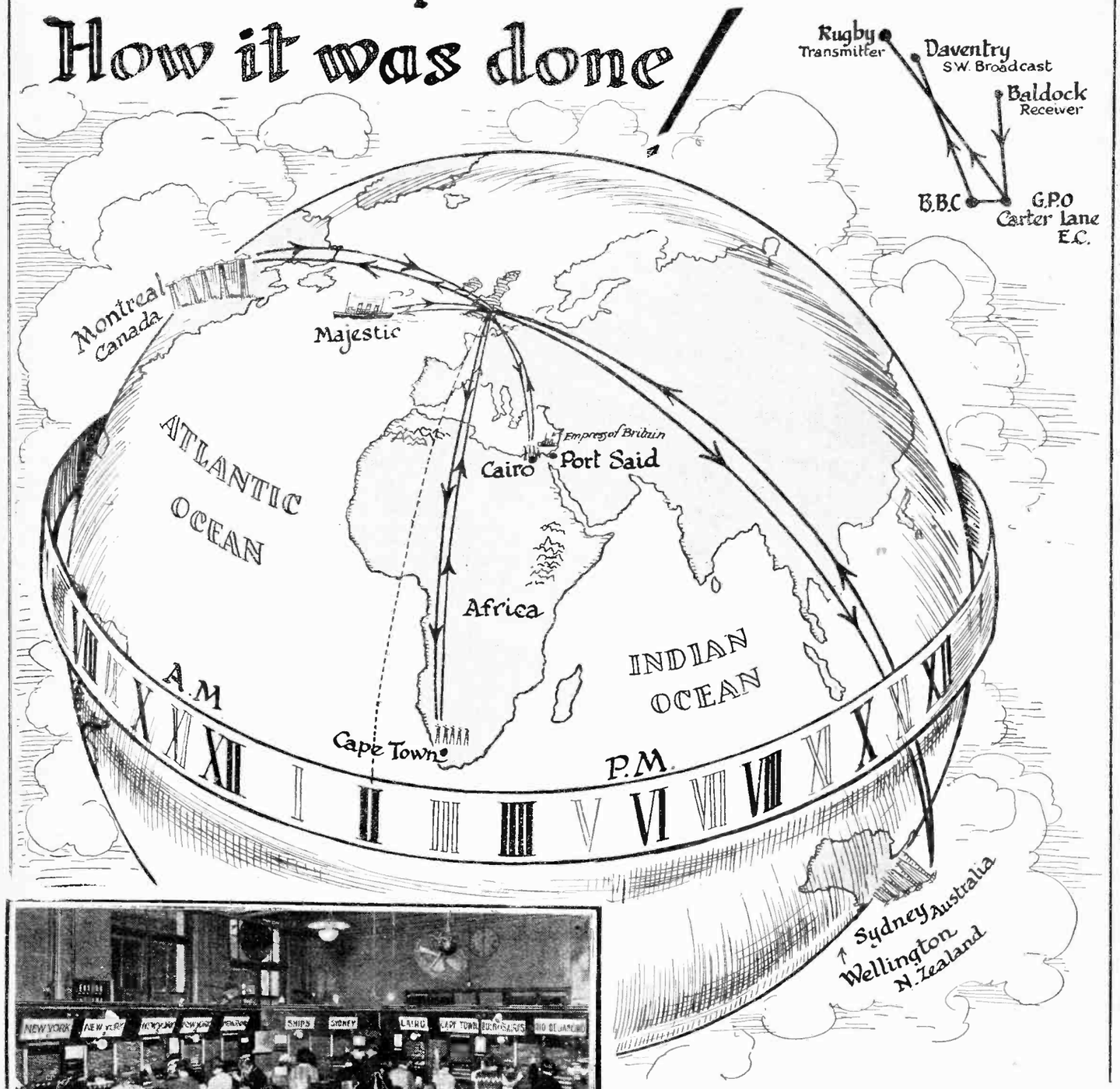


Apollo cabinet for the "Straight Three."

As an undrilled chassis is available the cabinet will be found equally suitable for housing other types of set.

The Empire Broadcast

How it was done



The Post Office international telephone exchange at Carter Lane, London, E.C., round which the whole Empire programme revolved. Picked operators handled the calls. The messages were passed through to the B.B.C. control room at Broadcasting House.

HISTORY can offer no precedent to the great broadcast on Christmas Day when wireless girdled the British Empire. The exchange of greetings was organised by the B.B.C. and made possible by the use of the Post Office beam telephone circuits and the ship-to-shore service.

The programme opened at 2 p.m. (G.M.T.), and thereafter listeners were wafted to the R.M.S. Majestic in mid-Atlantic; the cities of Canada, Australia, New Zealand, South Africa; then to the Empress of Britain in Port Said Harbour; and finally to Sandringham, where His Majesty the King broadcast a personal message to all his subjects.

The globe shows at a glance how the historic Empire broadcast was carried out. The time factor played a large part, for it will be seen that at 2 p.m. (G.M.T.) Christmas Day was coming to an end in Australia while Canada was saluting the happy morn.

Outstanding Battery Set Development

Pentodes in Quiescent Push-pull

By E. YEOMAN ROBINSON

(*Chief Engineer, the Mazda Valve Laboratories*)

THE heart of many a conscientious set designer is broken when he tries to develop a battery set which will do justice to his ideals of quality of reproduction, for, whilst engineering knowledge tells him that a power output of about one watt is necessary, common-sense dictates that no H.T. battery is obtainable at a reasonable cost which will supply this power. Even with a high-efficiency pentode the drain on the H.T. battery for the power output valve would be about 20 milliamperes.

Moving-coil Output

Several methods of reducing the drain due to the power valve on the H.T. battery have been developed in the Mazda Radio Valve Laboratories. In one method about to be described two high-efficiency pentodes are operated in push-pull and are biased such that when no signal is received the H.T. consumption is negligible, and when a signal is received the anode current consumption is proportional to the amplitude of the signal. The result is amazing. A power output of 1.3 watts is obtained with a total H.T. consumption of only about 6 milliamperes at 120 volts H.T. This remarkable result opens up a new era in battery set design. A moving-coil loud speaker can be used, and a battery set can be built to give a performance comparable with that of a mains set. The method is termed "the quiescent operation of pentodes in push-pull."

Let us investigate how this high power output is obtained. When a valve is used normally a signal is applied to the grid, as shown at A, Fig. 1. The bias G is given a value such that the greatest possible grid swing can be accommodated, i.e., without the grid being carried positive during one half-cycle or beyond the cut-off point Q during the other half-cycle. The anode current when a signal A is applied is shown at B.

In quiescent push-pull operation two valves are used; one valve amplifies one half-cycle whilst the other valve functions as an amplifier during the succeeding half-cycle, each valve being substantially inoperative during the period when the complementary valve of the system is amplifying signals. The circuit arrangement for effecting this is shown in Fig. 2. The mechanism is illustrated in Fig. 3. Fig. 3 (a) shows the operating conditions of one valve. The valve is biased to P_1, i.e., substantially at the cut-off point. When a signal as represented at A_1 is applied to the grid, only alternate half-waves are amplified and the anode current is as shown by the full line B_1 (Fig. 3 (b)). The current in the complementary valve is shown by the dotted line C_1. These currents are combined by the output transformer to produce an A.C. current in the secondary winding as shown at D (Fig. 3 (c)).

HERE is important news for the battery set user. An output push-pull system is described which is capable of giving 1½ watts speech—generous moving-coil volume—for the remarkably small consumption of 5 to 6 mA., which is well within the discharge capabilities of the smallest H.T. battery. This development will evoke widespread interest and open up a new era in battery set design, for it means that those listeners unprovided with lighting mains can now enjoy the volume and quality of reproduction previously associated only with mains receivers. A constructional set including pentodes in quiescent push-pull will be described shortly.

The mean anode current is shown by the dotted line E_1 in Fig. 3 (b), from which it will be seen that the H.T. consumption is proportional to the received signal. With a strongly modulated signal the anode current is high; with a weakly modulated signal the anode current is low; whilst in the intervals or pauses in a programme the current is negligible. Contrasting this with single-valve operation, as illustrated in Fig. 1, it will be seen that in this case the H.T. current is constant whatever the value of the signal, and even when very weak signals are received the drain on the H.T. batteries continues. Since the output stage must be able to accommodate a peak signal corresponding to a 80-100 per cent. modulation, and the average modulation is only of the order of 15-20 per cent., the saving in anode current with quiescent push-pull operation is very great.

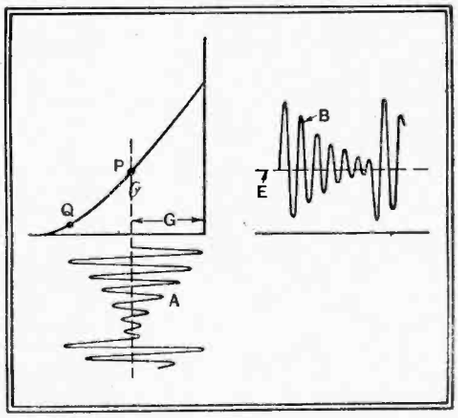


Fig. 1.—The process of amplification when a valve is biased to the centre of the linear portion of the characteristic.

The use of triodes in push-pull is well known, but in practice it is found that although efficient operation can be obtained, only a very small power output is available unless the grids are carried to high positive potentials. This introduces serious distortion unless a specially designed input circuit is used. There is also considerable difficulty in matching the triodes, since all the valve constants must be matched. By employing pentodes both these difficulties are overcome. A high power output can be obtained without running into grid current, and it is only necessary to balance the anode current of the valves at the bias point. Further, this balance can be easily obtained by adjusting the screen voltage of one valve.

Current Depends upon Signal

When a single triode output valve is used the maximum theoretical efficiency is 50 per cent. (i.e., the ratio of power output to power dissipated at the anode), but in practice the efficiency obtained is only about 20 per cent. With a single pentode the maximum theoretical efficiency is again 50 per cent., and with certain Mazda pentodes an efficiency of approximately 45 per cent. is realised in practice.

Outstanding Battery Set Development—

With high-efficiency pentodes operated in quiescent push-pull the theoretical efficiency is practically 80 per cent., and an actual efficiency is realised of well over 60 per cent. But this increase in efficiency, great though it is, is overshadowed by the saving due to the fact that the average modulation of a broadcast signal is only 15-20 per cent., and the "waiting time," i.e., the time during programmes when there is no signal, is considerable. The H.T. consumption of pentodes in quiescent push-pull depends, therefore, on the volume of sound at which the speaker is operated and the type of programme. It is higher for dance music than for a symphony concert.

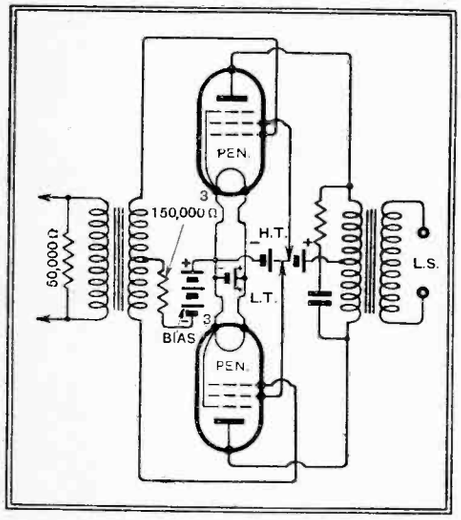


Fig. 2.—Two high-efficiency pentodes in quiescent push-pull. They are biased back to a high value and the anode currents are equalised by taking separate tappings for the screening grid feeds.

TABLE I.

H.T. Consumption of Output Valves required for 1.3 Watts Output. H.T. Voltage 120.

Output Stage.	Current.
Triode.	55 mA.
High-efficiency pentode.	24 mA.
Quiescent push-pull pentodes.	6–7 mA.

In Table I the H.T. consumption which would be required to give a maximum undistorted power output of 1.3 watts is given for a triode, a high-efficiency pentode, and two high-efficiency pentodes in quiescent push-pull, when an H.T. voltage of 120 is available. The figures for the quiescent pentodes include the screen current and are the average over an evening's programme.

Matching the valves

Let us refer again to the circuit of Fig. 2. From a study of this it will be seen that several features have been introduced which have been found to be essential for the successful operation of pentodes in quiescent push-pull. First, a resistance of 150,000 ohms is included in the lead to the centre tap of the secondary winding of the input transformer. The purpose of this resistance is to prevent parasitic oscillations being generated by the pentodes. Since the pentodes are connected in push-pull and high-gain valves are used, parasitic oscillations will be produced on peak signals, giving an unpleasant distortion, unless this anti-parasitic oscillation resistance is employed.

Secondly, the primary of the transformer must be shunted with a resistance of approximately 50,000 ohms. If this resistance is omitted it will be found that when the anode circuit of the detector valve is broken, either by disconnecting the H.T. lead or by pulling the detector valve out of its socket, a large voltage surge is produced in the secondary of the transformer. This surge may put a high instantaneous positive potential on the control grids of the pentodes, with the result that the pentodes may be damaged or the filaments even burnt out by reason of the high space current taken by the valve. The resistance across the primary of the transformer reduces considerably any danger from surge. It cannot be too strongly stressed that if this resistance is omitted and the H.T. circuit of the detector valve be broken the pentodes will probably be damaged. The value of the resistance will depend upon the make of transformer employed. It is therefore advisable to keep to the following rule:—

> Do not break any circuits in the set or pull the detector valve from its socket unless the filaments have been switched off. Switch the set on and off by breaking the filament circuit.

The primary of the output transformer is fitted with a resistance-capacity filter for the purpose of keeping the load impedance in the anode circuits substantially constant throughout the audio-frequency range. In this connection it should be mentioned that, owing to the great increase of impedance with frequency of moving-iron speakers, these instruments cannot satisfactorily be used with pentodes in quiescent push-pull.

The pentodes are given a common bias, and the quiescent currents are balanced by adjusting the screen voltages. In setting up the circuit the recommended bias should be applied and the screen voltages adjusted so that the feed current of each valve is approximately 2 mA. when Mazda Pen. 220A valves are employed, and 1.25 mA. when Mazda Pen. 220 valves are used. In order to provide the necessary gradation in screen volts it is desirable, but not essential, to use an H.T. battery which is tapped in 3-volt steps.

A 120-volt H.T. battery will have a voltage of approximately 126 when first purchased, and at the end of its useful life will have a voltage of 95 to 100. Throughout the life of the H.T. battery the voltage on the anodes and screens will therefore gradually fall. To avoid frequent resetting of the bias, the bias battery should be discharged at the same rate as the H.T. battery by means of a discharge resistance. The average consumption of the Mazda Pen. 220 and Pen. 220A valves, when used in quiescent push-pull, is given in Table II. With this information and the knowledge as to the H.T. consumption of the rest of the set, the value of the discharge resistance can be computed.

TABLE II.

Summary of Operating Conditions of Mazda Type Pen. 220 and Pen. 220A Valves in Quiescent Push-pull.

	Pen. 220.	Pen. 220A.
H.T. voltage	120	120
Bias voltage (recommended)	—6.8	—14.5
Max. undistorted power output (milliwatts)...	690	1,300
Plate-to-plate load for M.U.P.O. (ohms) ...	40,000	18,000
Grid swing per valve (R.M.S.)	4.85	10.6
Quiescent anode current (mA.) (two valves)...	2.5	3.5 to 4.0
Average anode current when operating (two valves)	3.0 to 4.5	5.0 to 6.0

There is one further minor point for providing perfect balancing: the outer grid of the pentode is connected to one end of the filament. For identification purposes, on the Mazda valve, the filament pin to which this grid is connected is marked with the figure "3" on the base. This pin should always be connected to the negative L.T. accumulator and negative H.T. battery. Thus a little care is necessary in wiring up the sockets of the output pentode valves to see that pin No. 3 is connected correctly.

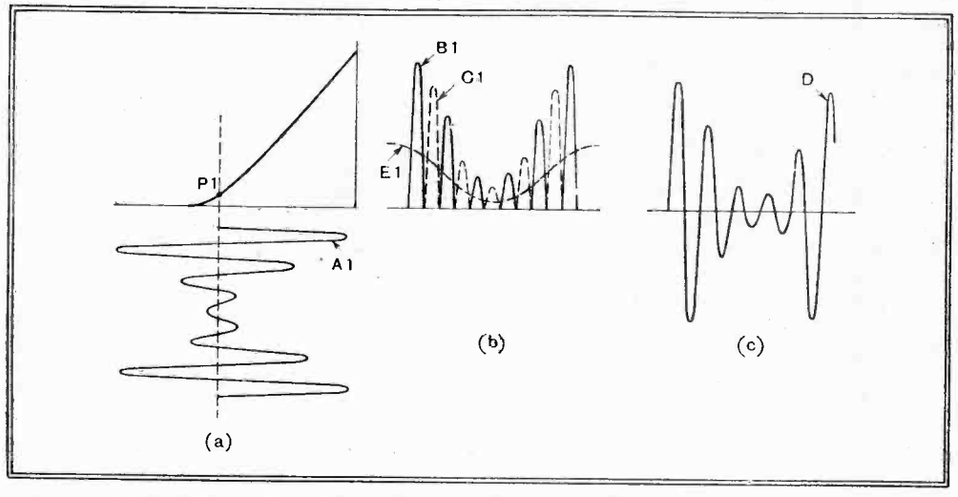


Fig. 3.—(a) A single pentode biased back nearly to cut-off point. (b) The anode current waves for two valves which are combined together by the output transformer to give the type of output shown at (c)

Outstanding Battery Set Development—

Fig. 4 shows the maximum power output obtained from two Mazda Pen. 220A valves in quiescent push-pull plotted against load impedance when 120 volts H.T. is employed. Second harmonic distortion is negligible; third harmonic distortion limits the load resistance which can be employed. The percentage third harmonic distortion obtained is also shown in the figure. From these curves

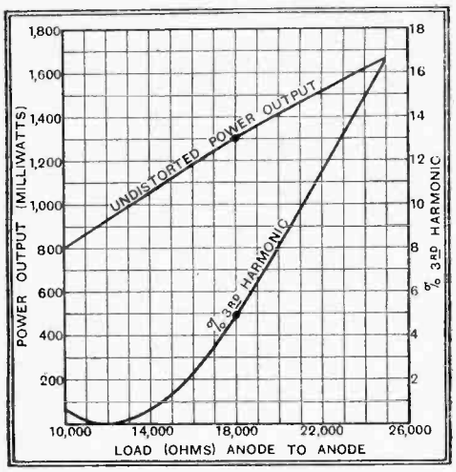


Fig. 4.—Curves showing undistorted power output and third harmonic distortion for two Pen. 220A valves in quiescent push-pull, working into various loads.

it will be seen that with a load of 18,000 ohms the power output obtainable is 1.3 watts, whilst the third harmonic distortion is 5 per cent. When no signal is received the total feed current of the two valves is 4 mA. When a continuous signal of constant and maximum amplitude is received, the anode current consumption for the two valves is 16 mA., but on ordinary broadcast reception the average consumption is only 6 to 7 mA. This figure has been determined by leaving sets running for a whole evening's programme with an ampere hour meter connected in the anode circuit. The performance of the Mazda Pen. 220 and Pen. 220A valves is summarised in Table II.

Output and Input Transformers

A word of warning is necessary with regard to the selection of the output transformer for use in this circuit. The calculation for the ratio of the transformer is different from that used for normal push-pull, because with large inputs only one valve is operating at a time, the other valve being inoperative during the major portion of the half cycle. When only one valve is in operation the output transformer acts as a 1 : 2 step-up transformer, so that the equivalent speaker load across the whole primary—that is, the plate-to-plate load, is four times the actual working load per valve. Referring once more to Table II, it will be seen that the recommended plate-to-plate load for the Mazda Pen. 220A valve is 18,000 ohms; the actual load in the anode circuit of the valve is, however, one-quarter of this, namely, 4,500 ohms.

It is not generally realised that some output transformers are very inefficient, and although there is ample power available with two Mazda Pen. 220A valves for operating a moving-coil speaker, disappointing results will be obtained if the output transformer is of low efficiency, especially when the H.T. battery has run down in voltage. As a rough guide, the primary resistance of a transformer primary, measured from plate to plate, should be not more than 500 ohms when Mazda Pen. 220A valves are employed, and 800 ohms when the Pen. 220 valves are used. If the transformer is otherwise correctly designed these figures will permit a transformer efficiency of approximately 85 per cent. to be obtained.

The best value of the filter for limiting the rise in load impedance will depend on the high notes lost in the receiver due to side-band cutting, etc. It will thus vary according to the receiver and to the tone requirements of the user. As a rough guide a filter consisting of a 0.01 microfarad condenser and a 20,000-ohms resistance will be found satisfactory. If the reproduction is a little harsh, the resistance should be reduced, and if it is too mellow the resistance should be increased or may even be eliminated.

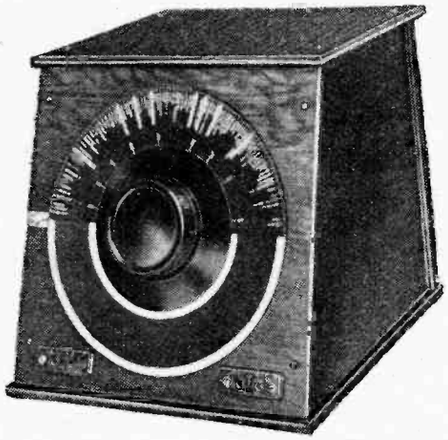
The push-pull input transformer must be of high ratio to avoid overloading of the detector. A 10 : 1 ratio is a recommended value, giving a 5 : 1 step-up to each grid of the pentode valves.

In Next Week's Issue

The Wireless World STATION FINDER

Gives a Direct Answer to the Question: "What Station Is That?"

A SWING of the indicating dial, and the name of the station that is being received is clearly shown on a large printed scale. Compare this with any of the usual methods of identification, which involve several operations and cross-references, and, as an example, take the well-known practice of calibrating a 0-100 or 0-180 tuning dial in wavelengths.



Simple enough for the beginner: accurate enough for the most critical.

After a lengthy preliminary calibration, identification is secured only after four operations: (*a*) accurate reading of scale to at least half a division, (*b*) transfer of reading to calibration chart, (*c*) estimation of corresponding wavelength, (*d*) reference to station-wavelength list.

The use of dials marked in wavelengths, even if the indications be correct and can be read with sufficient accuracy, involves operations (*a*) and (*d*). Similar cross-references are also necessary with most other devices.

The Wireless World Direct-Reading Station Finder, designed for home assembly, can be put together in an hour, and is as simple in operation as in construction. Although it is an electrical device, intended for external connection in the aerial circuit of almost any receiver without internal alteration, no valves or batteries are needed. It will double the interest of long-distance reception, and, while being simple enough for the new reader who has not previously undertaken the assembly of apparatus, will appeal equally to the experienced amateur.

It is seldom that initial adjustments will take more than five minutes, as the Station Finder is almost self-calibrating. Although it is a precision instrument, designed to have an average error not exceeding one-half of 1 per cent., the essential components cost less than a pound.

LIST OF PARTS

1 Variable condenser, 0.0005 mfd. Log. mid-line	Cyldon, Type D5
1 Semi-variable condenser, 0.00007 max.	Cyldon, Type ST70
1 Special dial, 4in. diameter	Cyldon
1 Station Finder coil assembly	Tunewell
2 Twin socket strips, "A1, A2"; "blank."	Belling-Lee
1 Cabinet	Myers-Hunt Cabinet Co., Ltd.

Screws: 6 ⅜in. No. 4 R/hd., 2 ½in. No. 6 R/hd.
Two lengths sleeving; 2 yds. No. 22 tinned copper wire.

THE BROADCASTER RADIO AND GRAMOPHONE TRADE ANNUAL FOR 1933

THE second edition of this invaluable book contains most of the features which proved of such service in last year's publication, with several important additional sections, including tabulated data, giving the total number of householders in each district and the number of houses on A.C. and D.C. supply, respectively. Localities where the mains supply is on standard synchronous frequency are also specially indicated.

There is a useful series of Abacs which should prove of great assistance in radio servicing. The main provisions of the Import Duties Act of 1932 and the R.G.2 (Radio-Gramophone) Agreement for the use of "key" patents are also given, the book is, in fact, filled with valuable information which will undoubtedly prove of service to the radio and gramophone trade alike.

Pp. 232. Published by the "Broadcaster and Wireless Retailer," London, and supplied (to the trade only) for 5s. post free.

Practical HINTS AND TIPS

AIDS TO BETTER RECEPTION

Tone Control for Speech

WHEN operating a "quality" set which gives a large undistorted output, it is almost invariably found that the volume control setting which is satisfactory for reproduction of music is quite unsuitable when speech is being transmitted. Volume will be excessive, and the speech will appear altogether unnatural. The obvious thing to do, of course, is to make suitable adjustments of volume for each type of transmission. This is satisfactory enough, but there is an alternative plan—that of reducing apparent loudness of speech by attenuating the lower audible frequencies. It may seem a retrograde step even to suggest such a scheme, which, of course, amounts to nothing more than the deliberate introduction of frequency distortion. But it is a fact that this plan often gives better intelligibility at average volume than is attainable by other means, and is one which is widely adopted by critical listeners.

Various methods of introducing bass attenuation have been discussed from time to time in this journal. Users of the "Monodial Super" and similar receivers based on this design may be interested to know that the scheme in question may be applied very simply to their receivers. Bass response may be reduced at will by shunting the coupling condenser in the tone-corrector valve grid circuit with a considerably smaller condenser. The component in question, numbered C15 in the original description, has a value of 0.01 mfd.; the parallel-connected capacity may be of anything between 0.0005 mfd. and 0.001 mfd., the best capacity being found by trial. A semi-variable condenser is very satisfactory for the purpose, and to make the plan entirely practical a switch should be fitted in order that the extra condenser may be thrown in or out of circuit at will.

Tracing Intermittent Cracklings

OF all the faults to which a wireless receiver is liable, the most annoying are those of an intermittent nature. Like the traditional aching tooth, they are apt to cure themselves suddenly at the very moment when it is decided to make a determined effort to remove the source of trouble. Clearly, patience is needed, and, unless one happens to be particularly lucky, the location of the fault is likely to take some time.

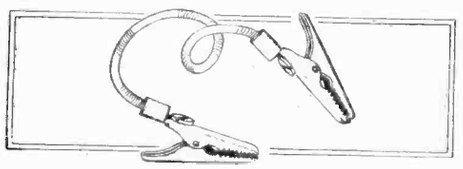
It will be assumed that the aerial has been temporarily disconnected, and, from the fact that intermittent cracklings still occur, it has been rightly deduced that they are due to the receiver itself, and not to interference from external sources. Instead of disconnecting components and testing them separately, it is generally quicker to localise the trouble by applying a series of short-circuits to the receiver, working in a logical sequence and rather in the manner usually adopted when tracing hum in a mains-driven set.

If it be decided to follow this plan, the method of procedure illustrated diagrammatically in Fig. 1 will usually be found best. Although a simple battery-operated H.F.-det.-L.F. set is taken as an example, the scheme is clearly applicable to any type of receiver.

Almost invariably it will be best to make a start at the output end of the receiver and to work backwards, "shorting" each grid circuit in the sequence shown in the diagram. If the noises cease as a result of a "short," it may be assumed that all succeeding circuits are in order. As soon as a point is reached where the "short" has no effect, it may be deduced that the fault lies between that point and the last at which silence was obtained.

Referring to the diagram, if noises persist after bridging the L.F. transformer secondary terminals (points A and B), it will be proved definitely that the fault is due either to the output valve, the loud speaker, the source of H.T. supply, or, just possibly, to the G.B. battery.

But, on the other hand, if complete silence be obtained, we know that all these components are free from blame and that the fault lies nearer to the input or "aerial" end, and that investigations must be carried a stage farther. This is done by "shorting" the detector grid leak (E, F); a recurrence of noise will indicate a faulty detector valve, H.F. choke, or L.F. transformer, while silence shows once more that the defect is still nearer to the aerial and that the short-circuit must be transferred to points M, N. Deductions will still be made in a similar manner.



A handy connecting link for applying short-circuits without disturbing existing wiring.

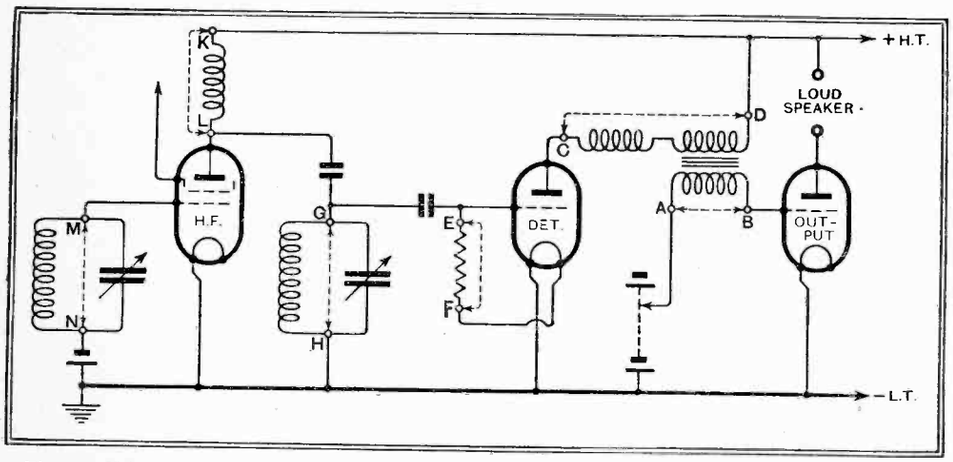


Fig. 1.—Where temporary short-circuits should be made when localising intermittent faults by a process of elimination.

Short-circuiting with Safety

In addition to the testing points mentioned, others are shown in the diagram; these may be regarded more or less as alternatives, to be used when they are more accessible, or even to narrow down the field of search. Points C, D are virtually almost equivalent to A, B, while both K, L and G, H are in parallel with E, F. It is worth while pointing out that defects —particularly in H.F. circuits—are often more readily perceptible when the set is tuned to a fairly strong carrier wave while tests are being made.

It will be fairly obvious that this method of testing offers the great advantage that none of the internal wiring of the receiver need be disturbed. If, at the worst, results are not entirely conclusive, the fault will have been localised in a single circuit, or, at any rate, in a small section of the receiver.

As an aid to making tests of this nature, a length of flexible insulated wire with a crocodile clip at each end is most useful, as it enables the appropriate points to be bridged with a minimum of trouble and without the need for unscrewing inaccessible terminals, etc.

UNBIASED

By FREE GRID

Arriving at the new unit.

A Hot-water Unit

I HAVE had to complain previously of the looseness of technical expression adopted by many so-called wireless experts, but little did I think that I should find the same sort of thing existing in the parent science of electrical engineering, or that I should have to reprove a member of the Institute of Electrical Engineers for his conduct in this respect.

It so happened that, pursuing my policy of making my house an all-electric, all-radio one, I recently decided to install an electrical system of constant hot-water supply. I wrote asking for all details concerning running costs, etc., and in reply I received a long, meandering letter from the resident engineer of the Supply Company to the effect that, so far as running costs were concerned, it had been found that the hot-water consumption of a family of six for baths and all other purposes worked out at about 3s. a week.

Quite naturally I wrote back, asking what multiple or sub-multiple of a kilowatt-hour was "the consumption of a family of six," as I had never previously heard of this new electrical unit. I expressed interest in my letter as to the manner in which this new unit was arrived at, for, as I explained, I could point to families of a dozen or more whose hot-water consumption per year worked out at considerably less than the *daily* requirements of many families of one, and, if expressed in electrical terms, would be rather smaller than the power consumption of a flash-lamp bulb. So far, the learned M.I.E.E. has vouchsafed no reply to my letter, but I am living in hope.

Time, Gents, but—

I SCARCELY expected that my appeal for help in the matter of clock movements would meet with such a magnanimous response not only on the part of the general public, but also of the many manufacturers and vendors of these useful commodities. Among the latter I am particularly indebted to Messrs. Ferranti, Messrs. Garrard, and Messrs. Hancocks for their very "timely" reminders of the existence of clocks other than those of the scullery variety. May I extend my cordial thanks, also, to those members of the public who have so kindly written to me on the subject.

Alas, all has not run as smoothly as it might have done. So much have I missed the homely "tick" of the ordinary pendulum movement, which I slung out of my study in favour of a new electric instrument, that I have been unable to concentrate on my work. To restore my peace of mind, I have, therefore, been compelled to purchase a cheap spring-driven movement and fit it in the clock case at the back of the electric "works." Naturally, this device requires winding up periodically, and so one of the greatest advantages of a mains-driven clock is lost to me.

A Synthetic Tick

Surely it is not beyond the ingenuity of our manufacturers to turn out an electric clock with a small extra motor or other device for the express purpose of creating a synthetic "tick." I feel sure that it is the ghostly, "creeping" silence of these mains-driven timepieces—as the auctioneers like to call them—that is preventing many people from buying them; consequently, there would be a large market for an instrument of the type I have mentioned.

I notice from catalogues that electric clocks are now obtainable, not only with Westminster chimes, but with an alarm movement as well, everything being electrically driven, and so the thing I ask for should be quite a small task for a manufacturer's technical department to tackle. If they can't devise electrical apparatus for producing a realistic "tick," the least they can do is to put in a clockwork movement for this purpose, and couple it to a small mains-driven motor which, by quite a simple mechanism, could be made to wind it up automatically every time it ran down.

It will be remembered that a gramophone motor operating on this principle was put on the market two years ago. I feel sure that, if electrical clockmakers followed suit, their enterprise would not go unrewarded.

At any rate, I would guarantee the purchase of at least one Elec-Tick clock.

For Services Rendered

I HAVE received many "touching" letters since the publication of the New Year's Honours List last Monday, but I regret to say that responsibilities entailed in the upkeep of my position forbid me to reply in the "concrete" manner I should like.

Troubles of a Gas Manager

"OH, what a tangled web we weave, when first we practise to deceive" is an old maxim beloved by schoolmasters and other persecutors of the young; but the truth of it has never been brought home to me so forcibly as the other day when I received an SOS from a friend whom I had not seen since pre-broadcasting days. He is manager and engineer of the gas-works in a provincial town some sixty miles or so from London, and by an odd chance his establishment adjoins the local electric light works. He is provided by his directors with an excellently appointed residence on the premises, and naturally all lighting and heating are done by gas, as anything electrical in his house would be as poor an advertisement for the stuff he sells as the sight of a doctor buying a bottle of patent medicine.

In order to enjoy the very acme of quality, coupled with good volume, he had built himself an all-mains set with a four-hundred-volts-on-the-plate type of output


Fame of colossal undistorted output had spread.

valve. The electric light manager next door, being a kindly man, had supplied him with a carefully concealed power lead, and he had himself skilfully hidden his mains set, deceiving visitors with an ostentatiously displayed three-valve battery receiver apparently coupled to his loud speaker.

Unfortunately for him, the fame of the colossal undistorted output which he obtains (apparently) from this humble three-valve set has spread throughout the town, so that he is literally besieged by visitors demanding the circuit from him. Up to the present he has staved them off with the old excuse that the circuit is a secret which he has promised not to divulge, but he realises that he can't keep this up for long, and has, therefore, sent for me to suggest a plan for getting him out of his trouble. It seems to me that a hurried departure from the town is the only way to avoid disaster. Any suggestions in this matter would be as welcome to him as the sight of land to a cross-Channel passenger.

NEWS of the WEEK

Current Events in Brief Review

Still More Power

THE power of the Beograd (Belgrade) broadcasting station is to be raised from 2.5 to 40 kW.

A new 20 kW. station is to be erected at Zagreb.

Not Afraid

"MAY I see the captain?" asked the young lady passenger. "He's forward, miss," replied the first mate. "Oh, I'm not afraid," said the lady, "I've been out with radio salesmen."—From the Mullard Magazine.

Five Lady Announcers

OUT of sixty candidates for the post, five lady announcers are competing at Radio Algiers for the final vote by listeners. The odds appear to be most heavily in favour of Mdlle. Coste, who, it is rumoured, gave great satisfaction at Poste Parisien during 1932.

Let us hope, writes a correspondent, that this Judgment of Paris will not, like its classic precedent, provoke jealousy and trouble, of which there is already more than enough in the wireless domain!

Drastic Remedy

IF the report is to be believed, Groningue, Holland, now possesses the first "Association of the Victims of Radio." This comprises a group of citizens exasperated by the noisy loud speakers of their neighbours. To obtain official support they have adopted the drastic remedy of renting rooms near the houses of official personages in the town, including the Governor of the Province, the Mayor, Deputy Mayors, Magistrates, and police officers. In these rooms they have installed gramophone pick-ups with powerful amplifiers and loud speakers, and up to a late hour at night the dignitaries are feasted with music and song.

Rumour has it that the Mayor is drafting an order which will put an end to these nocturnal attentions.

Poles May Now be "Hams"

THE Polish postal authorities have now authorised individuals and associations to operate radio transmitters on all waves provided that the tests are of a genuine experimental or amateur character.

A Correction

IT is regretted that in our issue of December 16th, 1932, it was suggested that A.V.R.O.—the neutral broadcasting association of Holland—had signed a contract for microphone facilities at Luxembourg. We are asked by the association in question to state that no such contract has been entered into.

200 kW. from Paris?

AT Villejust, near Paris, the French Government has decided to construct a 120 kW. broadcasting station to replace the present Paris PTT "poste," and we understand that the transmitter is already under construction by the Société Francaise Radioélectrique. The wavelength of the station will be 447 metres.

It is stated that, if necessary, it will be possible to raise the power to 200 kW.

Who's Huizen?

THE great Hilversum-Huizen controversy has been reopened by the change-over which occurred on New Year's Day when the long-wave station at Huizen was handed over to the A.V.R.O. and V.A.R.A. organisations, who nevertheless continue with the Hilversum announcement. Similarly, the K.R.O. and N.C.R.V. associations, in taking over the Hilversum station, retain the Huizen announcement.

So, for the next three months, if you hear Hilversum it's Huizen, and vice versa!

LOUD SPEAKERS IN THE MAKING. A photograph taken in a factory showing a moving-coil being fitted in position.

Echometer Reveals Errors

THE Marconi "Echometer," the sound apparatus for registering the exact depth of the sea under a ship, has undergone its first ship tests off the coast of Gambia, West Africa, in the trawler "Umberto Lupi." During the trials the echometer revealed many errors in existing charts of the ocean bed.

"Concert Hall" Studio for Hilversum

THE laying of the foundation-stone of the new offices of the A.V.R.O. Dutch broadcasting organisation in Amsterdam on December 17th is stated to be the prelude to big developments. Work is soon to be started on a great new broadcasting building at Hilversum with a concert hall studio.

200 Kilowatts Calling

LUXEMBOURG—Europe's giant transmitter—has sprung a surprise by starting tests with its maximum aerial power of 200kW. on a wavelength around 1,200 metres, despite the fact that it has been refused a wavelength of this order by the Madrid Conference. The station has been heard at great strength on several recent mornings.

Physical Jerks from South Africa

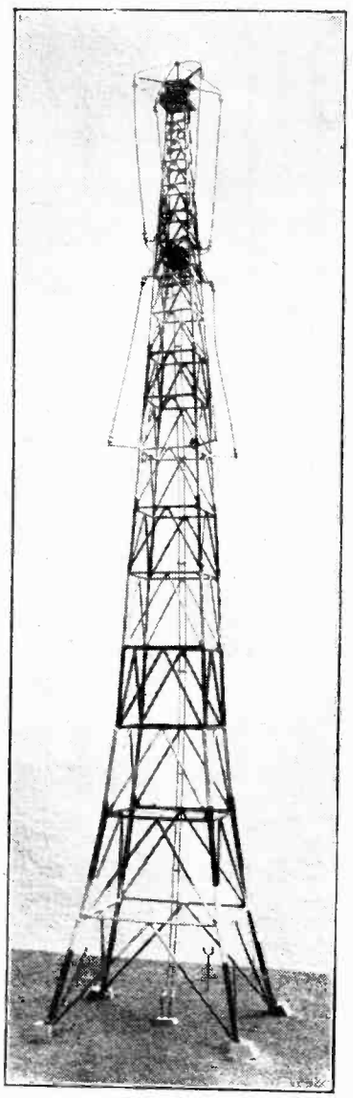
"PHYSICAL Jerks" can be picked up any morning between 4.45 and 5.20 (G.M.T.) broadcast from Johannesburg on 49 metres. The station, ZTJ, also works on 447 metres. The midday programme can be heard between 9 a.m. and 12 noon. South Africa's other large broadcasting stations are Cape Town (ZTC), on 371 metres, and Durban (ZTD), on 415 metres.

Radio Barter in Prague

THE first permanent radio junk sale has been inaugurated in Prague. The price of new radio sets having been found prohibitive, Prague listeners have instituted a central exchange where accessories of all nationalities, makes, and vintage years can be bargained for. In this way the humble listener or set constructor can acquire the parts he needs without recourse to the radio profiteers.

A New Power War?

THE decision of the Madrid Conference to limit the power of European broadcasting stations to 200 kW. has resulted in a general urge for more power among the lesser stations. It is understood, for example, that the projected power increase of the Brussels stations from 15 to 75 kW. is a move to counteract the expected interference from the new 120 kW. station at Bisamberg, near Vienna. Likewise, other countries are seeking to raise their broadcasting power up to the maximum number of kilowatts.



AN ANTI-FADING AERIAL. The Telefunken Company in Germany having set the fashion in aerials for accentuating the ground wave, the Lorenz firm has retorted with a new type of mast-aerial aiming at the same effect. The photograph shows a model of the Lorenz aerial.

B.B.C. Chairman on Empire Broadcasting

THE Right Hon. J. H. Whitley, late Speaker of the House of Commons and Chairman of the British Broadcasting Corporation, will address a meeting of the Royal Empire Society at the Hotel Victoria on Tuesday, January 17th, at 8.30 p.m.

The subject of his address will be "Broadcasting to the Empire and the New Service," and the chair will be taken by Dr. Montague Rendall, who was a Governor of the B.B.C. from 1927 until the end of 1932.

Readers of *Wireless World* wishing to attend should make early application for a ticket, or tickets (for which no charge will be made), to the Secretary of the Royal Empire Society, Northumberland Avenue, London, W.C.2.

The MODERN D.C. THREE

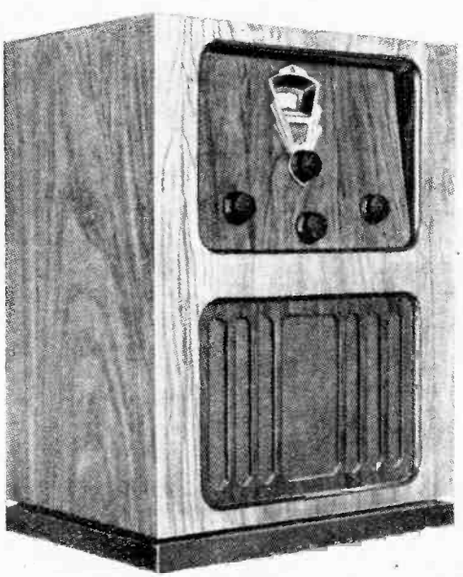
Constructing the Receiver and Making Initial Adjustments

By W. I. G. PAGE, B.Sc.

IN last week's issue the chief considerations in designing a modern straight receiver for D.C. mains were discussed and stress was laid on the need for an energised speaker with a powerful magnetic field. Owing to depleted anode volts the output from a D.C. set is often disappointing unless the speaker is exceptionally sensitive. Moreover, there are other advantages of high magnetic field strength, such as better reproduction of transients giving colour and character to speech and music.

The tuning unit chosen for inclusion in the receiver has many circuit innovations which were explained at some length in the first instalment. Constant sensitivity over the wavebands is one development of importance, and a new aerial coupling scheme, which prevents slight misalignment of ganged circuits so often experienced with the more orthodox aerial coupling, is embodied. To improve selectivity and to ensure the highest possible rectification efficiency, a screen-grid detector is used. Curves under working conditions were given, and demonstrated that this type of valve is more than 2½ times as sensitive as a typical triode, and, furthermore, there is the minimum of de-ganging of the preceding tuned circuit.

The construction of the set should present no difficulty if reference is made to the various drawings and photographs in this and the first instalment. A start should be made with the Radiopak, which is bolted through the Plymax baseboard, and "local" earth is picked up underneath at all the four points of anchorage. There are two terminals marked "DG," and, as these are electrically the same, it is found better to use the left-hand contact, this giving the shortest lead. The metal strip supplied with the potentiometer holds both the latter component and the reaction condenser in position, and the whole assembly is held away from the base of the Radiopak by means of two distance pieces. It was found that, in order to provoke oscillation, only quite a small reaction condenser was necessary, the value chosen being 0.00015 mfd. This can be accounted for by the negligible damping of the tuned circuit by the screen-grid detector.

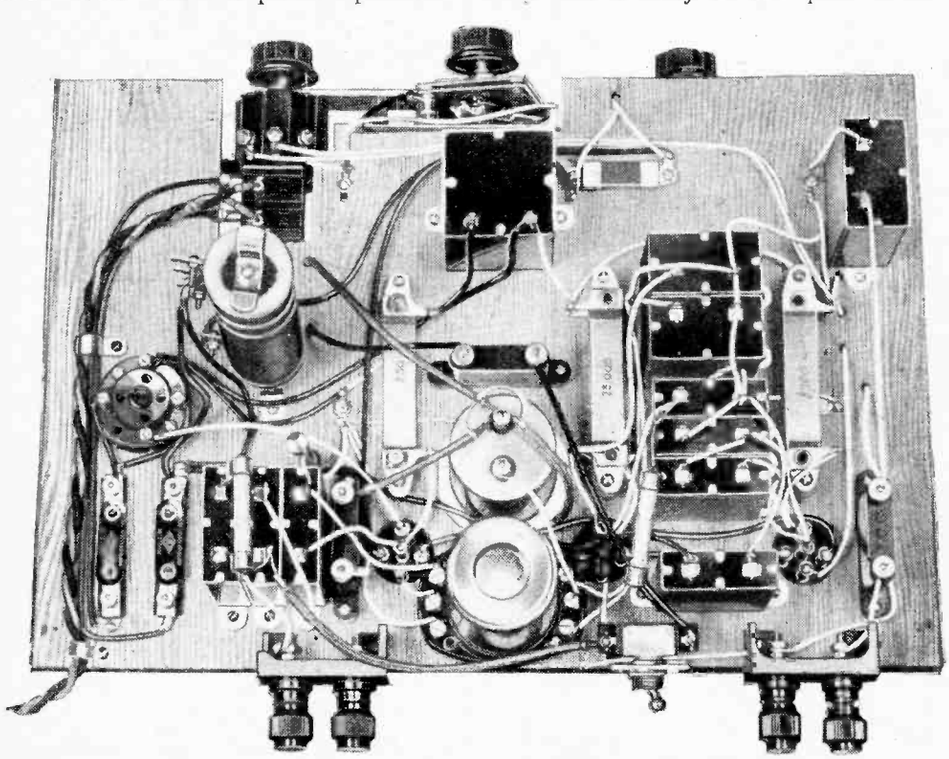


The controls are arranged on a sloping panel which gives a pleasing appearance to the set.

The next components to be mounted are the two L.F. chokes and the three valve holders, which complete the upper deck. On the underside the only difficulty that is likely to take place is the wiring of the strip resistances, which are built up vertically above one another in series of three. It should be noted that the resistance nearest the baseboard in the pack close to the H.F. valve holder is R6, the middle resistance is R3, and the top member R4. In the other pack the order outwards from the baseboard is R9, R10, and R11. Care must be taken to connect the Transfeeda correctly. Terminal HT1 is taken to the high-tension line, P to the H.F. choke, GB to C18 and R14, and HT2 to the decoupling condenser C17. The speaker is connected by a four-pin plug and a four-membered flexible cable, the transformer primary being joined to the filament pins and the field to the grid and anode.

The gramo-radio switch is mounted on a small aluminium angle bracket which is supplied with the Plymax baseboard, and, to avoid instability, screened leads must be used where shown in the wiring plan.

After the set has been completed and the lamp holder adaptor or plug connected to the supply mains, it may be found that signals cannot be obtained, although the pilot lamp and valve heaters are seen to be alight. This is, of course, due to a reversed polarity connection, and the plug or adaptor must be changed round. The heaters of the D.C. valves take rather longer to warm up than those of the A.C. type, and full emission must not be expected until some forty seconds after switching on.



Practically all the wiring is confined to the under-baseboard where the decoupling and by-pass components are housed.

Wavelength Calibration

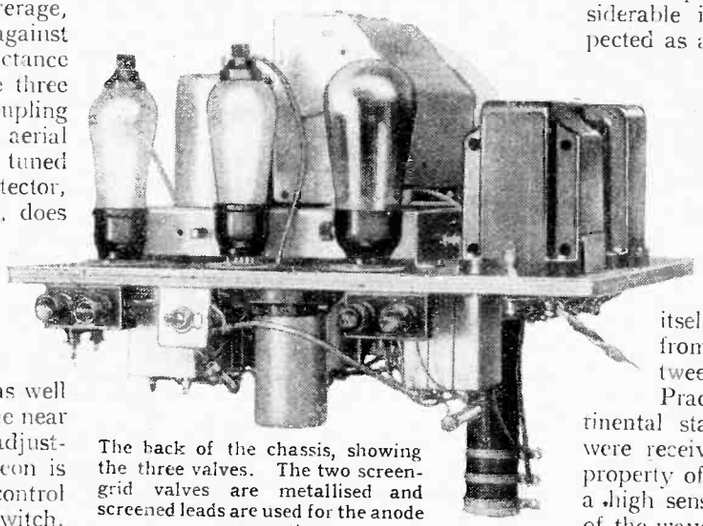
The balancing of the three variable condensers of the Radiopak is extremely simple. It is only necessary to set the tuning dial, which is wavelength-calibrated, to the wavelength of a station near the lower end of the medium band, and change all three trimmers by means of the insulated tool provided until the signal is at a maximum. Those living in London or the Home Counties would cali-

For the convenience of readers constructing this set, blue prints of the wiring diagram and general layout can be obtained from the publishers, price 1/6 post free.

The Modern D.C. Three—

brate the set using the London National station, turning the dial to 261 metres and adjusting the three trimmers. Provided the balancing is correct at the lower end of the medium band, it will be found to hold accurately over both ranges. Ganging with this receiver will be maintained with a precision that is above the average, owing to two factors which militate against unequal stray capacity and inductance being thrown on to two out of the three tuned circuits. First, the aerial coupling is unconventional and prevents the aerial reactance from de-ganging the first tuned circuit; secondly, the screen-grid detector, having a negligible "Miller" load, does not disturb the third circuit. A word of warning is necessary in regard to the trimming operation, for with mains in which the positive lead is earthed the whole Radiopak and all metal screening is "live," and it will be as well to slip a piece of thick paper over the near edge of the tuning unit while the adjustment is being made. The escutcheon is electrically isolated, and all the control knobs, including the radio-gramo switch, are "safe," as the grub screws, where these are used, are well countersunk.

The background is particularly quiet, and hum can only be detected when the ear is within a foot or two of the loud speaker with either a positive or negative earth on the supply. With mercury-arc systems, which, fortunately, are few and far between, a negative-earth supply will not give much trouble, but in a house where there is a positive earth a certain amount of hum will be heard unless additional smoothing equipment is included. In this special case it will be as well to try the effect of two H.F. chokes of low D.C. resistance and a couple of series-connected 1-mfd. condensers as described by W. T. Cocking in an article entitled "Design of D.C. Sets," which appeared in the issue dated November 18th, 1932. The junction between the two condensers can be taken either to local earth (the Plymax baseboard) or be made the main earthing point of the set. If this does not effect a cure, more inductance must be put in series with CH1 and CH2 and additional capacity shunted to earth. Considerable improvement can also be expected as a result of increasing the capacity of C2 and including chokes capable of carrying 0.25 amp. in one or both of the heater leads.



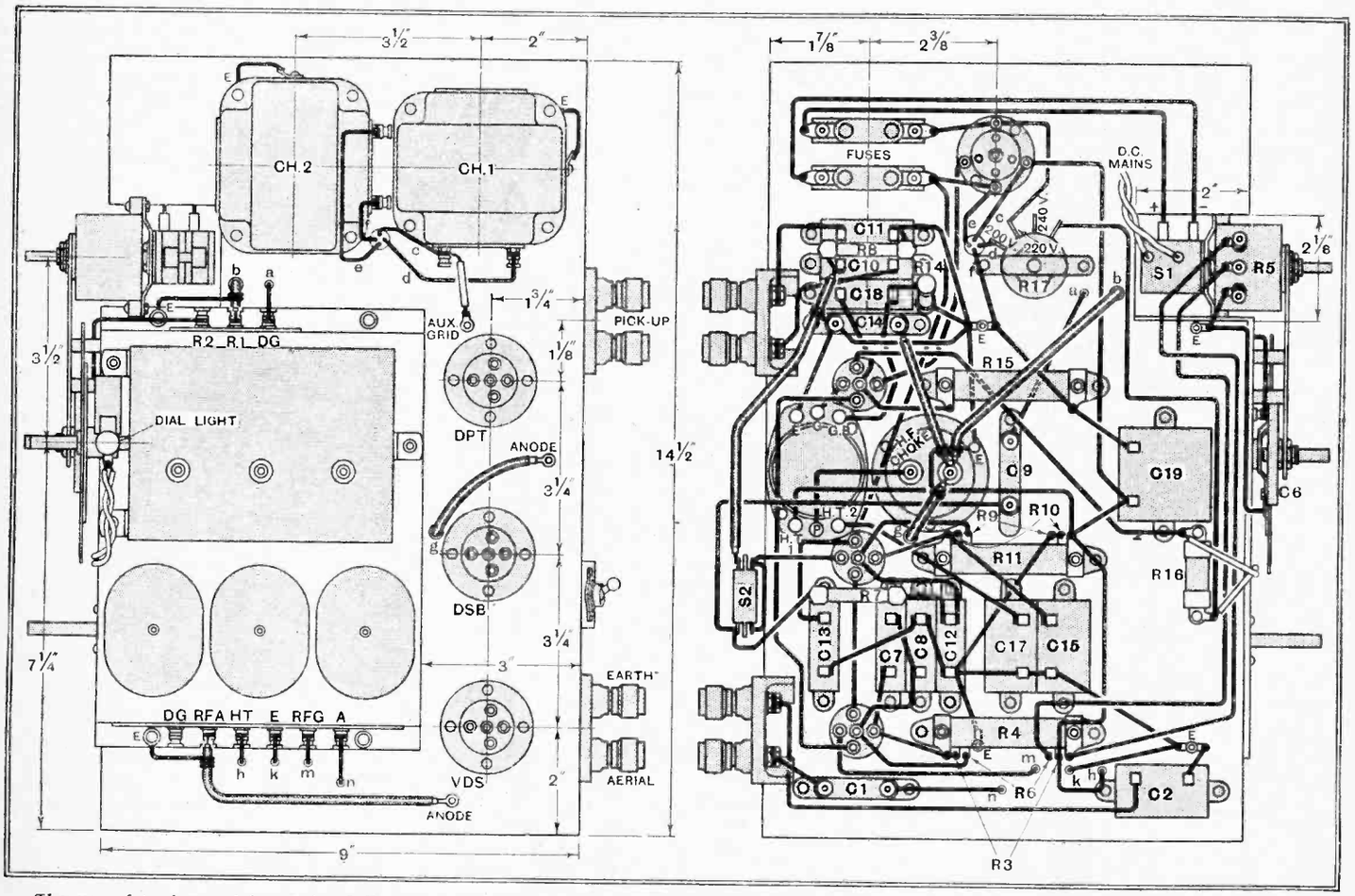
The back of the chassis, showing the three valves. The two screen-grid valves are metallised and screened leads are used for the anode connections.

High Sensitivity

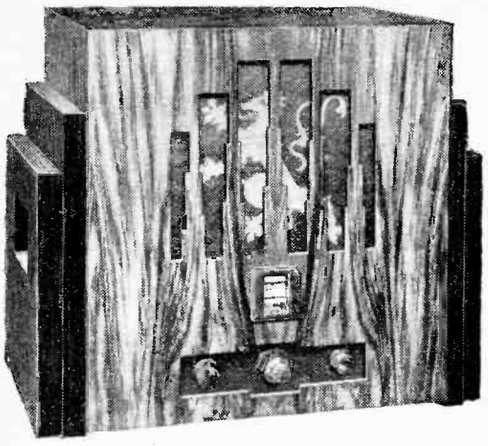
When tested a few miles from Brookmans Park the receiver gave a good account of itself, and a number of stations free from interference were logged between the two local transmissions. Practically all the British and Continental stations of entertainment value were received at good strength, and the property of the tuning unit of maintaining a high sensitivity level at the upper end of the waveband was most marked. Stations above, say, 420 metres, which usually require the assistance of reaction, came in at adequate strength without the use of subsidiary controls.

A specimen receiver built to this design is available for inspection at 116/117, Fleet Street, London, E.C.4.

DIMENSIONAL DATA AND WIRING PLAN OF THE MODERN D.C. THREE



The use of tuning and intervalve L.F. coupling units considerably reduces the number of connections which have to be made. Care must be taken in wiring the strip resistances which are built up into packs.



The Climax
BAND-PASS THREE
A Self-contained A.C. Mains Set

SO far as that most important attribute of a broadcast receiver, its power of reproducing without distortion, is concerned, the popular type of three-valve mains set need be in no way inferior to many more ambitious types of receiver; indeed, its very simplicity may give it some advantage in this respect. In the matter of sensitivity, too, it can meet most requirements, thanks to modern high-efficiency valves and circuits. It is usually on the score of selectivity that the simple three-valve set may prove inadequate to meet the demands of the long-distance listener, particularly when he happens to be situated within a few miles of a broadcasting station.

The selectivity of a receiver, however, depends not only upon the number of tuned circuits included in the design, but also upon their efficiency, and, by paying attention to detail, it is possible to effect considerable improvement. In the Climax set under review this has been done, as the results amply demonstrate. Although no one would expect the selectivity to compare with that given by a superheterodyne, for instance, there is no question that it is unusually high for a three-valve set, and it compares well with that obtained with the average four-valve straight set containing four tuned circuits.

At a distance of no more than nine miles from the Brookmans Park transmitters it proved possible to receive some six stations on wavelengths midway between those of the two locals, and the Scottish Regional station could be obtained clear of the London Regional. As these two stations are separated by only 46 kc., it will be seen that the spread of the local has been confined to remarkably small limits. The adjacent channel selectivity, as distinct from the power of eliminating a strong local, is also good, and all the more powerful of distant transmitters were receivable without serious interference from their immediate neighbours.

Resistance-coupled H.F. Filter

An examination of the circuit diagram reveals that the H.F. valve is of the screen-grid type, and is coupled to the power grid detector by the tuned anode circuit, to which reaction is applied in a conventional manner. In the pre-selector circuits, however, an unusual method of coupling has been adopted. Instead of the normal capacity or inductance coupling, resistance is employed. On the medium waveband a low-value resistance is common to both tuned circuits, and provides the requisite coupling, while on the long waveband the coupling is augmented by the connection of a high-value resistance between the high-potential ends of the two tuned circuits.

Good Frequency Response

A variable condenser is connected in series with the aerial, and acts as the volume control, and it is in connection with this that the sole point of adverse criticism can be found, for the range of control which it affords is inadequate to deal with a powerful local. The difficulty can, of course, be got over by the simple expedient of disconnecting the aerial for local reception.

FEATURES

Circuit.—*Screen-grid H.F. stage with tuned anode coupling and two-circuit resistance-coupled pre-selector. Power grid detector transformer coupled to a penlode output valve. Valve rectifier for the H.T. supply.*

General.—*Self-contained receiver with mains aerial and moving-coil loud speaker, the field of which is energised from the smoothing circuit. Provision for use of a gramophone pick-up.*

Controls.—*(1) Single tuning control with illuminated and calibrated dial. (2) Reaction control. (3) Combined wave-change, radio-gramophone, and on-off switch. (4) Volume control.*

Price.—*16 guineas.*

Makers.—*Climax Radio Electric, Ltd., Parkhill Road, Hampstead, London, N.W.3.*

The detector is transformer coupled to the output pentode, which in turn feeds the moving-coil loud speaker through a transformer. It is interesting to note that the bias resistances of both the output and the detector valves are not by-passed, nor are the grid circuits decoupled. This departure from normal practice naturally results in there being anti-phase feed-back from the anode to the grid circuit of the pentode, and the efficiency is reduced somewhat. Efficiency is of secondary importance to quality, however, and as the feed-back along a simple by-passed resistance is the same for all frequencies there can be no loss of bass. Actually, the insertion of the usual by-pass condensers, without decoupling resistances also, would give inferior quality. Decoupling in the anode circuits is equally scanty, but this leads to no trace of observable feed-back effects, and the receiver is perfectly stable and has a satisfactory frequency response.

The H.T. supply is obained by means of a valve rectifier, and the smoothing equipment is generous. Both the mains transformer and the choke are of large dimensions, and appear likely to perform their allotted functions indefinitely. The choke, in conjunction with electrolytic condensers, provides the initial smoothing, and this is completed by the field winding of the loud speaker; the result of this combination is highly satisfactory, and there is a total absence of hum when the ear is at a distance of only six inches from the speaker cone.

Mechanically, the construction is extremely clean, and there is evidence of careful thought in the layout of components. The chassis is aluminium finished and is rigid, and the majority of components are located on its under side. The valves are readily accessible for replacement, and, as a safety device, the hinged back of the cabinet is so arranged that it cannot be opened while the mains are connected.

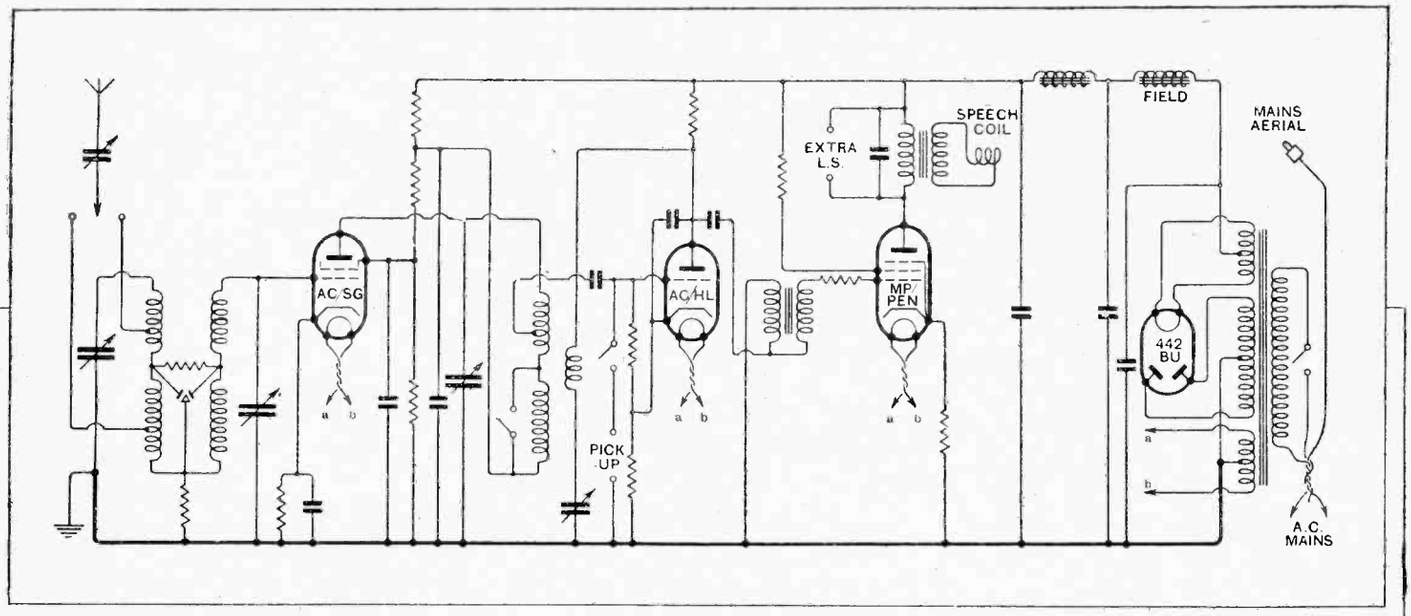
The Controls

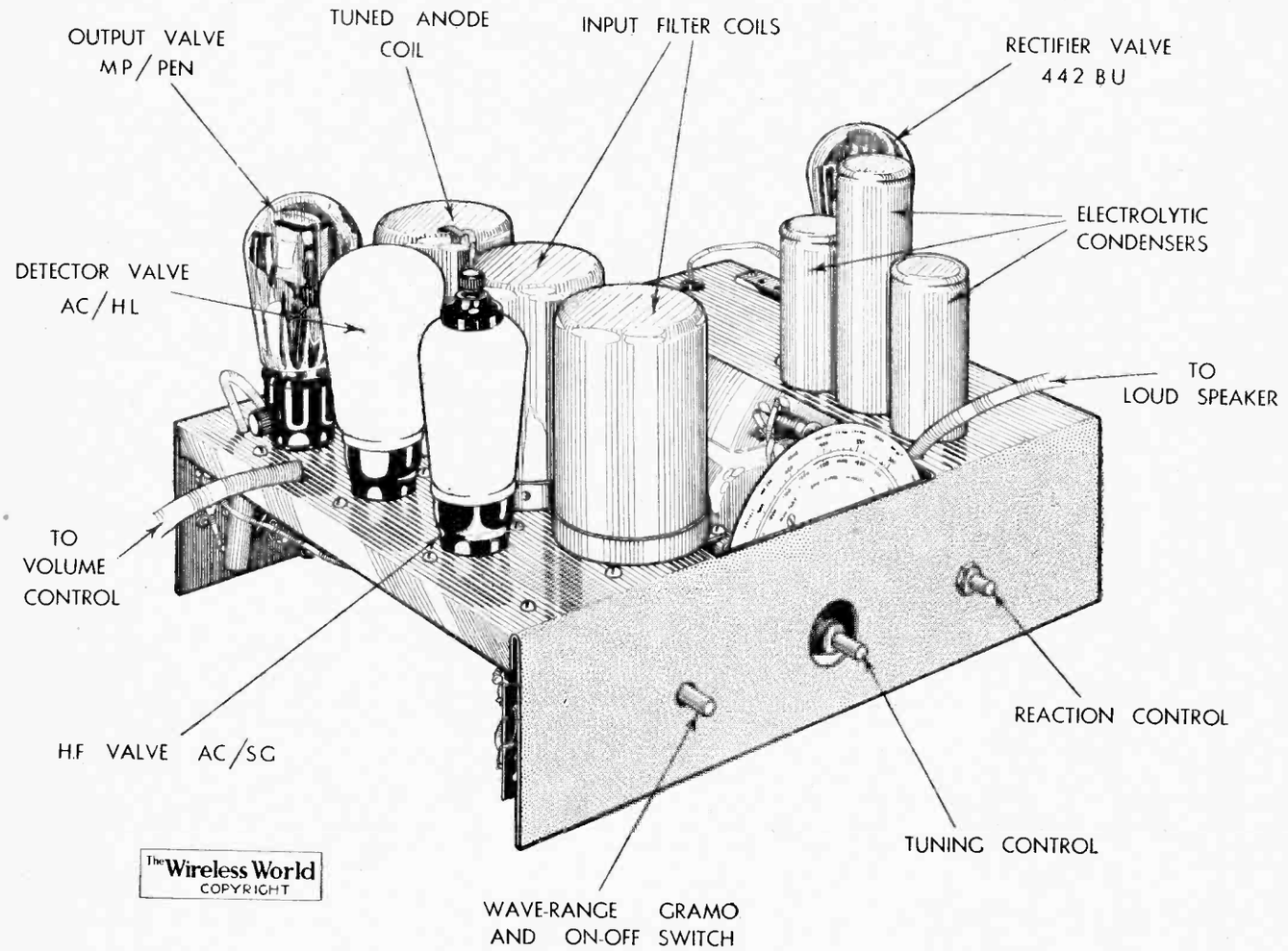
The tuning controls consist of the knob controlling the calibrated and illuminated dial, the reaction control, and the combined wave-change, radio-gramophone, and mains on-off switch. There is also the aerial volume control, and this is conveniently fitted in a recess at the left-hand side of the cabinet.

A mains aerial is incorporated, and proved surprisingly efficient. Even without an earth connection, numerous distant stations were available, but hand capacity to the volume control was then apparent. With an outdoor aerial and earth no trace of this effect could be found, and the set proved very simple to operate. The sensitivity was adequate for any ordinary conditions, and apart from the blanketing of the locals over certain portions of the tuning scale practically every worth-while station could be tuned in at full loud-speaker strength.

As already pointed out, the selectivity is very high for this class of set, and the quality of reproduction also proved to be exceptionally good. Both low and high notes were well represented in the output, and no part of the frequency range appeared to be over-stressed. The undistorted output obtainable is considerable, and the reproduction is singularly free from both harmonic distortion and noticeable resonances.

Highly Selective Straight Set



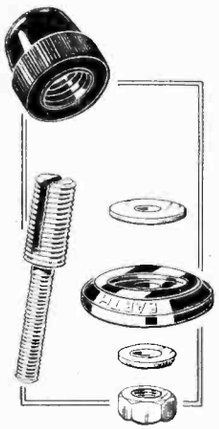


Circuit diagram and chassis details of the Climax Band-pass Three. An unconventional filter coupling is used in the pre-selector.

LABORATORY TESTS

B.B.C. TERMINAL

A NEW terminal made throughout of bakelite and fitted with a neat dome-shaped head has been placed on the market by S. Lilly & Sons, Ltd., 80, Alcester Street, Birmingham.



B.B.C. "all-insulated" bakelite terminal.

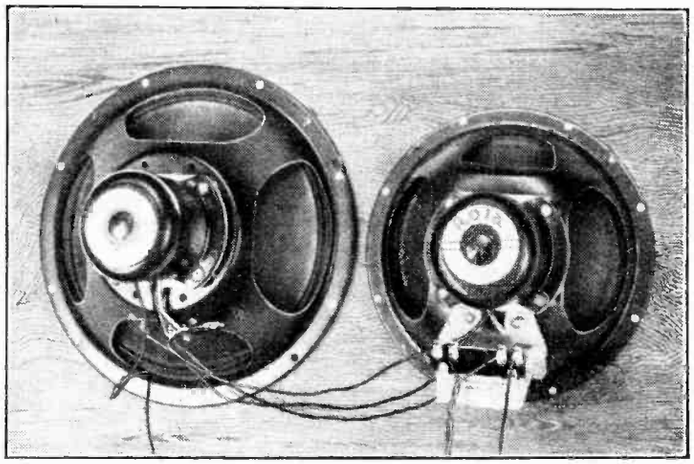
Known as the B.B.C. "All-insulated" terminal, it is designed to take either spade-end connectors, pin-type connectors, or bare wire. They are available in black or red and with all the usual markings, and the price is 2½d. each.

Incidentally, the shank of the terminal is not insulated, so that when it is mounted on metal chassis or panels, insulating bushes must be used.

ROLA DUAL LOUD SPEAKERS

THE dual balanced pairs of Rola type F loud speaker units are available in a wide variety of combinations which include both permanent magnet and energised types. The pair tested comprised an F6 (7¾in. cone) and an F7 (9in. cone)—both energised and with 2,000-ohm field windings and hum-bucking or hum-neutralising coils.

A single output transformer is fitted to the F6 chassis and supplies both speech coils in parallel. As a result, the distribution of current tends to counteract the effects of mechanical resonances and to produce a smoother overall response. The benefits of this arrangement are most marked at the lower end of the frequency scale and result in a particularly rich and full bass response without any trace of boom. The output is well maintained down to 70 cycles, and there is only a slight falling-off even at 50 cycles.



Rola type F6 and F7 mains energised units connected as a "dual balanced pair."

There is a detectable resonance between 2,800 and 3,000 cycles, but this is not sufficient to cause shrillness, and the output in the middle and upper registers is well matched to the excellent bass response.

Care is necessary in connecting the units to see that the coils move in the same phase. This is easily judged by ear; if there is a poor bass response either the speech coil or the field winding on one of the units should be reversed.

The price of the combination tested is £4 5s., and the makers are The British Rola Co., Ltd., 179, High Road, Kilburn, London, N.W.6.

NEW RADIO PRODUCTS REVIEWED

BALDWIN TEST SETS

TWO exceedingly useful test sets, one for capacity measurements and the other for measuring resistances, have been developed by the Baldwin Instrument Co., 24, Well Hall Road, Eltham, London, S.E.9. The former is described as the "Mufer" Bridge, and has a range of from 0.00005 mfd. to 4 mfds., the actual capacity of the condenser under test being read off directly from the scale. It is constructed on the bridge principle, and is energised by a neon tube oscillator which requires between 120 and 160 volts, this being supplied by an external battery. The current consumed is very small, being less than 0.1 milliamp.

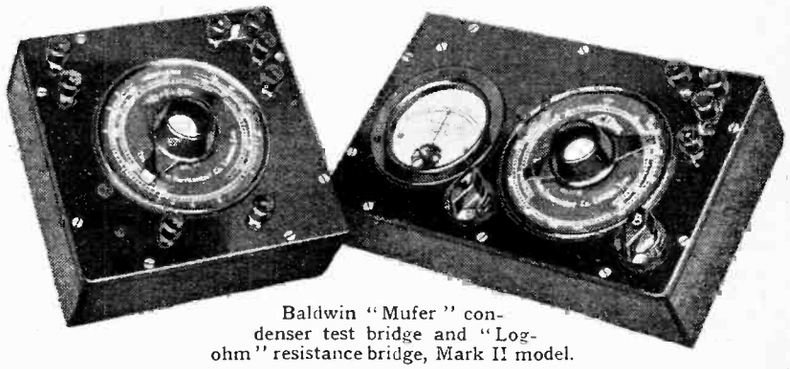
The bridge has two ranges, the lower extends from 0.00005 mfd. to 0.015 mfd., while the higher covers all capacities from 0.015 mfd. to 4 mfds.

On test we found this instrument to be exceedingly accurate, the largest error recorded being a shade over two per cent. Over the major part of the scale the error was of the order of one per cent. only, which, considering the very reasonable price, which is but 75s., is exceptionally good. It may reasonably be regarded as a precision instrument.

The "Logohm" resistance bridge is made in two types, a Mark I model and a Mark II model. Both embody the same general principle, the difference being that the Mark II style is a complete instrument and includes a galvanometer and a small battery. The Mark I model includes the essential parts of the bridge only and requires an external galvanometer and battery.

The D.C. resistance in ohms of the component under test is read off directly from the scale and two ranges are provided. The lower range extends from 0.5 ohm to 150 ohms, and the higher range from 150 ohms to 40,000 ohms.

Our tests show that the accuracy obtainable with this instrument is exceptionally high, for measurements made with laboratory sub-standard resistances failed to reveal an appreciable error greater than that introduced in reading the scale over the major part of the range. Resistances can be measured within two per cent. of their actual value if a little care is exercised in reading the scale.



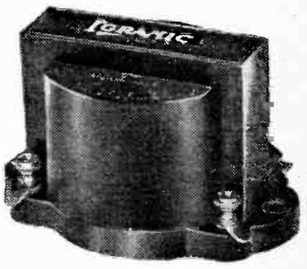
Baldwin "Mufer" condenser test bridge and "Logohm" resistance bridge, Mark II model.

The Mark I model costs 70s., and the price of the complete instrument, Mark II, is 110s.

IGRANIC T.24B TRANSFORMER

MADE by the Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4, the Type T.24B intervalve L.F. transformer is available in two ratios, viz., 1 : 3 and 1 : 5, the price being 5s. 6d. in each case. Tests made with a specimen 1 : 3 model connected in the anode circuit of a valve of 10,000 ohms A.C. resistance and with 1.5 mA. flowing in the primary show the amplification to be sensibly constant above 1,000 cycles and up to 8,000 cycles. The greatest increase does not exceed 1.5 decibels over this part of the audible scale as compared with the amplification at 1,000 cycles.

Below 1,000 cycles the amplification falls off gradually and the level is depressed by about 15 decibels at 100 cycles. It is only below 300 cycles, however, that the reduction in amplification becomes apparent. Considering the very reasonable price of the component its performance is quite satisfactory, for over the major part of the audible scale the amplification is sufficiently well maintained to preserve a good balance of reproduction.



Type T.24B Igranic L.F. transformer, ratio 1 : 3.

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The 1933 Radio Catalogue recently issued by Dayzite, Ltd., 17, Lisle Street, Leicester Square, London, W.C.2, contains 120 pages devoted to illustrations and descriptive matter of the extensive range of proprietary receivers and components handled by this firm.

BROADCAST

By Our Special Correspondent

Why America was Cross

WHILST agreeing with the attitude adopted by the B.B.C. in the matter of the King's Empire speech, I can understand the annoyance of the American Press. Repeated requests had been made that His Majesty's speech might also be extended to the broadcasting networks in the United States; when permission was refused, on the grounds that the broadcast was essentially of an Empire nature, the Americans were indignant.

Very sad. But the United States are not part of the Empire, however much they would like to be!

A Word for the Post Office

By the way, it seems to me that not enough credit has been given to the Post Office for the major part which it played in the great Empire programme on Christmas Day. Actually, the whole of the "Round the Empire" feature was conducted from the international switchboard of the Post Office at Carter Lane, E.C., through which the messages passed to and fro between Broadcasting House and the scattered outposts of the Empire.

How Others Heard

More than this. The Post Office also retransmitted the programme by beam telephony to Canada and Australia, which (*pace* the B.B.C.) were the only parts of the Empire remaining in touch with the programme from beginning to end.

A New Record

DURING 1932 the B.B.C. stations broadcast for 58,163 hours with breakdowns amounting to only 0.023 per cent. of the total transmission period. This was even better than the year before, when the breakdown percentage was 0.03.

The Big Three

The "Three Big Events" of the year were: The opening of Broadcasting House, the inauguration of Scottish Regional and that of the Empire broadcasting station.

Provinces Not Forgotten

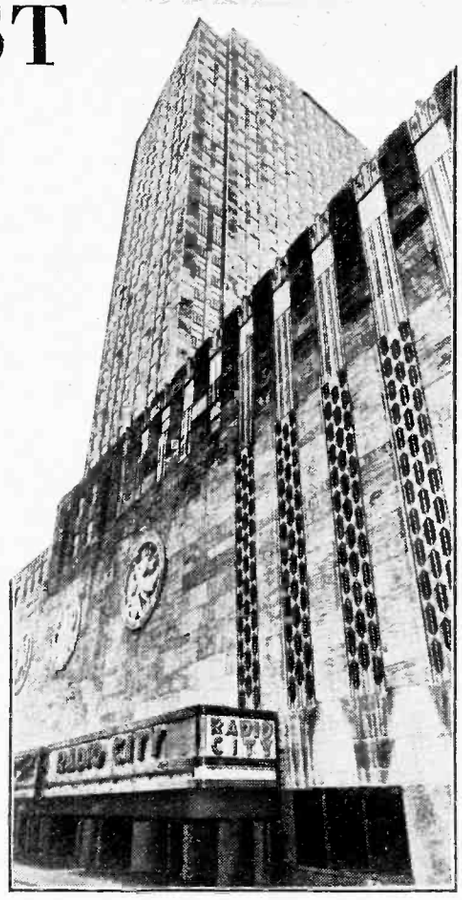
Any suggestions that the provinces were not being adequately looked after by the B.B.C. were swept aside during 1932 when the Corporation set about replacing studios and control gear all over the country.

Edinburgh and Manchester were both provided with studio accommodation second to none, while work is still proceeding at Birmingham on the new Midland Regional headquarters. Bristol will soon be provided with studios and offices worthy to be associated with the centre of West Regional broadcasting activities.

Success of Christmas "Proms"

The Old Year went out with the promise of still better things to follow. The last-minute decision to install the rebuilt long-wave National station at Wychbold, Droitwich, was announced during the last days of the year, and it was on New Year's Eve that an important experiment began—the broadcasting of Christmas "Proms."

The success of these new concerts is such that the B.B.C. have already practically decided to repeat the innovation a year hence.



THE FIRST STAGE. On December 29th New York flocked to the opening ceremony of the great theatre which forms part of the "Radio City" now being erected on Broadway. The photograph shows the imposing entrance.

Curious?

One curious feature of 1932 has been the absence of any great newcomers to the microphone. There has been no Kreisler or Caruso to burst upon the ether with a new style.

No showman has stepped along to demonstrate that present-day broadcasting technique is all wrong.

We welcome the opportunity of congratulating both the Post Office and the B.B.C. on their splendid co-operation on Christmas Day which resulted in the most impressive broadcast yet staged. Let us hope that this great event may be the prelude to still greater achievements in the cause of Empire unity.

An Empire Pamphlet

IN the making of B.B.C. pamphlets there is no end, but there seems reasonable excuse for the forthcoming "Empire Service" brochure, which will be chiefly for Empire consumption. It will tell briefly how the technical difficulties have been tackled at the Daventry short-wave station, how the programmes are being planned, and what the B.B.C. recommends that listeners should use in the way of receiving apparatus.

As regards Empire receivers, the general consensus of opinion is in favour of the simple "superhet." type, but the problem is complicated by the fact that three distinct classes of listener must be catered for.

BREVITIES

The Simplest Set

There are (a) the man with an electric mains supply, (b) the man with a battery charging plant within easy reach, and (c) the unfortunate who is many miles from even the smell of electricity, save in a thunderstorm.

The last-named class of listener wants the simplest and most economical form of set going, a description which hardly applies to a superhet.

"As You Were" at Daventry

THOSE of you who dwell on the fringe of the Daventry (5XX) service area will have noticed the increased signal strength since a return was made to the original single-wire "T" aerial three weeks ago.

Tests had been made on a high-capacity antenna, but although these provided some useful data for the design of the Droitwich aerial they were not otherwise successful.

Mr. Bartlett's Tours

PROBLEMS of the day in foreign countries are to be dealt with by Mr. Vernon Bartlett in a new series of talks which begins next week. Mr. Bartlett, who has been broadcasting from various countries to British listeners, will return home for one brief talk on January 12th and will then explain to listeners his plans for the ensuing series which involves a further foreign tour, in the course of which it is hoped that he will be able to bring to the microphone some of the men prominent in the political and public life of various countries.

"Hassan" Revival

IT is a sign of the growing antiquity of broadcasting that references are now made to "the older generation of listeners." These hoary folk are invoked by the B.B.C. in a publicity note concerning "Hassan"; they, it is urged, will associate the name of Cecil Lewis, the producer, with this great poetic play by James Elroy Flecker, which was broadcast in November, 1926.

The play is to be revived next month and will be broadcast in two parts. The music is by Frederick Delius.

The Flora of Portland Place

THESE must be great days at the Langham Hotel, which, of course, is the nearest hostelry to the new Broadcasting House. People are saying that already a definite track can be discerned on the roadway between the two buildings. This may be so, but I hesitate to associate the track with the new bar which, I am credibly informed, the Langham authorities have found it necessary to open recently.

Since the B.B.C. began the charming practice of filling its window boxes with flowers, the Langham has followed suit.

A Collection of Fossils?

I ALWAYS visualise the staff of the B.B.C. as overflowing with the energy that comes with youth and a clear conscience, but one of their correspondents apparently holds a different opinion, as a letter recently arrived at Broadcasting House addressed to "The Curator, British Broadcasting Corporation."

READERS' PROBLEMS

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers. Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page

L.F. Howling

A CORRESPONDENT tells us that his set works quite satisfactorily when it is used for the reception of near-by stations, but when reaction is applied for long-distance work there is a tendency for L.F. howling to develop. The set is a fairly conventional H.F.-det.-L.F. combination with grid leak detection.

An effect such as this is generally to be ascribed to the use of a detector grid leak of excessively high value; it may even be that the leak fitted is disconnected internally, and that the valve is only functioning by virtue of incidental leakages across its base or holder.

If the substitution of a new grid leak fails to put matters right, we suggest that the use of a lower ohmic valve than at present should be tried.

Grid By-pass Condensers

PROVIDED always that it be of fairly high capacity, "any old condenser" is generally considered to be good enough for decoupling or by-pass purposes in the grid circuit of an H.F. valve.

As the requirements here are perhaps rather less exacting than in an anode circuit, there is some justification for this attitude. A capacity of as little as 0.002 mfd. will often serve the purpose, but in cases of doubt it is wise to play for safety, and to adopt the more or less standardised value of 0.1 mfd.

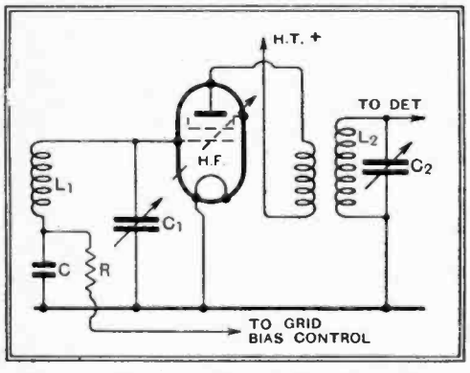


Fig. 1.—The capacity of the decoupling condenser C must be large in relation to that of the tuning condenser if accurate "ganging" is to be maintained. R is a decoupling resistance.

The ill effects of using too small a capacity are particularly likely to be noticeable when the condenser is included as a part of the tuned circuit, and trouble is almost certain to arise when this circuit is one of a series controlled by a ganged condenser. Unless the by-pass capacity be very large in comparison with that of the tuning condenser, perfect alignment of the circuits can hardly be obtained.

For instance, a reader submits a circuit diagram, of which the part in question is reproduced in Fig. 1. He finds that "ganging" does not hold, and asks for suggestions.

A value of 0.01 mfd. has been assigned to the by-pass condenser C, which is effectively in series with the circuit L1 C1. No such condenser figures in the circuit L2 C2, and so, even if these two circuits have identical coils and tuning condensers, their alignment cannot be perfect, as a condenser of 0.01 mfd. is small enough to affect appreciably the maximum capacity of the tuning condenser with which it is in series.

We suggest an increase to 0.05 mfd., or, even better, to the standard value of 0.1 mfd.

No Path for L.F

SOME time ago attention was drawn to the fact that receivers with a simple tuned-anode H.F. coupling sometimes show signs of L.F. instability, especially when anode current for the valves is obtained through an H.T. battery eliminator. Briefly, the reason for this is that L.F. impulses may be fed back to the detector through the associated grid condenser, and appreciable voltages may be built up across the grid leak.

A correspondent, recalling this statement, goes on to ask whether the "Straight Three," described a few weeks ago, is likely to give trouble on this score.

Although it is true that a tuned circuit is interposed directly in the anode circuit of the H.F. valve of this set, matters are so arranged that appreciable feed-back of L.F. voltages to the detector grid can hardly take place. Although the anode circuit is tuned, it is almost completely isolated, so far as L.F. impulses are concerned, from the detector grid.

Pick-up for the "Straight Three"

SEVERAL readers have asked how a gramophone pick-up may be connected to the "Straight Three" (described in our issue of December 16th).

Although more complicated change-over systems can be employed, it is more than doubtful whether their complexity is justified, and so we suggest the simple scheme shown diagrammatically in Fig. 2, where the additions are shown in dotted lines.

This represents the basic circuit arrangement, and does not include a volume control, which will in most cases be desirable. However, the diagram will serve as a guide to one querist, who states that his pick-up includes a built-in volume control; in this case he may join the leads shown as going to the pick-up to the input terminals of the particular accessory that he is using. Actually, of course, the appropriate connections to the controlling potentiometer will have been made internally by the manufacturers.

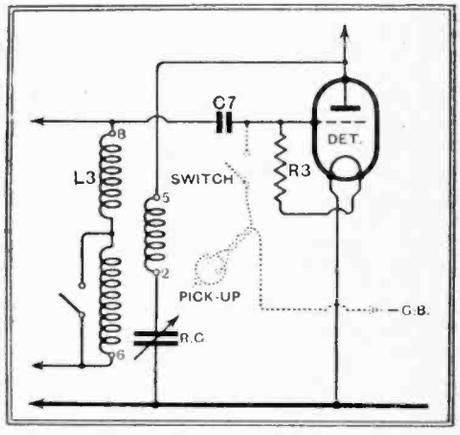


Fig. 2.—The simplest way of adding a gramophone pick-up to the "Straight Three."

Those who are fitting a separate volume control potentiometer should join the ends of the resistance element directly across the pick-up; the switch will then be connected to the slider, and the low-potential end of the resistance to G.B. negative.

Without an Oscillator

THE fact that audible signals can be received with a superheterodyne when the oscillator valve is disconnected, or even totally removed, is not of necessity an indication that something is seriously wrong, although it certainly rather implies that the signal-frequency tuning system could be improved.

For instance, if signals from two stations operating in channels separated from each other by a frequency equal to that of the I.F. amplifier are allowed to reach the first detector grid, they will, in combination, produce signals of the I.F. amplifier frequency, and so both programmes will be heard simultaneously.

A reader who has noticed this effect need not, in our opinion, be unduly perturbed. The stations are only heard—and that very feebly—when the volume control is at maximum; under these conditions a local station may cause a heavy flow of grid current, with the result that one of the preselector circuits may be seriously damped. Selectivity will then be reduced, and the interference effect will be noticeable. In normal circumstances, with the oscillator in operation, these conditions are not likely to arise.

The Wireless World

INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

The Wireless World

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CONTENTS

EDITORIAL COMMENT

Ether Congestion

Conditions Unlikely to Get Worse

A GREAT deal of exaggerated talk occurs to-day on the question of ether congestion and the difficulty of separating stations, and we are often told that sets of to-day are already mostly out of date and will be hopelessly unsuitable in a short time to come through lack of selectivity.

But let us examine the position from an unbiased point of view. It must be conceded at once that in this country the introduction of the alternative programme scheme put out of commission a large number of sets which were so unselective as to be unable to differentiate between, say, London Regional and London National.

Steps were at once taken to meet this new situation by designing receivers capable of giving selectivity sufficient to provide for foreign station reception under the most exacting conditions which can be imagined, namely, with a high power local station close by, when the foreign stations to be received were weak in strength by comparison. Increasing the power of foreign stations will, in a way, actually simplify the reception of these stations as alternatives to the local transmitter, for with field strength of foreign stations increased, any tendency on the part of the local transmitter to swamp them will be counteracted.

Only pessimists would visualise a state of affairs in Europe where the broadcasting authorities disregarded any attempt at organisation and grabbed each other's wavelengths without regard to overlapping. If we anticipated such a possibility, then indeed the outlook for reception in any part of Europe would be a sorry one, but we need not have any such misgivings, for organisation must remain, as otherwise reception, even of the local stations, would soon become impossible. Except in a few particularly ill-favoured localities, increase in power of Continental stations can only be regarded as a development which will give listeners a wider choice of programmes at better strength than they have hitherto enjoyed.

"What Station Is That?"

A Direct Answer at Last

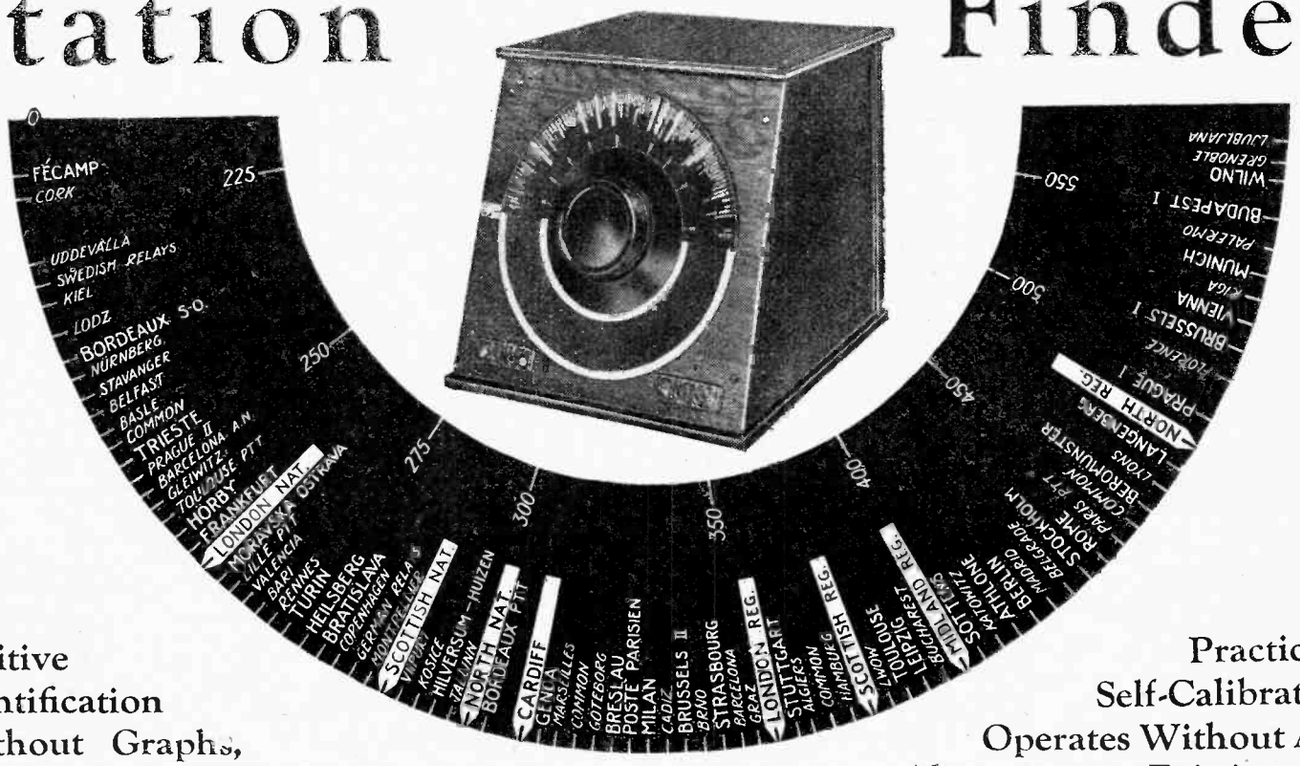
ALL listeners who ever hesitate over the identification of a foreign transmitter—and who does not?—will be interested in the new device described in this issue.

Ordinary wavemeters, if accurate enough for modern conditions, are fairly satisfactory as an aid to the positive identification of foreign transmissions. But, calibrated in the usual way, they have in the past failed to appeal to the average wireless user; perhaps the main reason for their lack of popularity is the fact that identification is only secured after going through a more or less complicated series of operations. The Station Finder indicates the *name* of the station actually being received, all intermediate processes being eliminated.

Such a station identifier is easy enough to make, but the finished article will be quite useless unless it can be accurately calibrated. The most attractive feature of the *Wireless World* Station Finder is that it is virtually self-calibrating, and that the simple initial adjustments that are necessary may be made without the use of instruments.

The form in which the device is presented is certainly the best for general use, and it will operate satisfactorily with the majority of receivers without any alteration.

The Wireless World DIRECT-READING Station Finder



Positive Identification Without Graphs, Charts, or Cross-References

By H. F. SMITH

Practically Self-Calibrating. Operates Without Any Alteration to Existing Sets

WHEN conditions are favourable, a good modern set will tune in a transmission at practically every scale division of a 0-100 dial. Probably the average listener cannot identify one-tenth of the stations receivable on such a set without a wearisome wait for an announcement—which does not always come, and, if it does, may convey no clue to identity. Even if he has taken the trouble to calibrate his set, a somewhat complicated process is necessary before he can be sure of the station that is being received.

No useful purpose would be served by a discussion of the shortcomings of the usual methods of identification, or by invidiously stressing the merits of the few receivers in the design of which a determined effort has been made to solve the problem.

Until all receivers are station-calibrated in a definite and really dependable manner, it would seem that there will always be a use for a "Station Finder." Without a trial, it is difficult to realise the interest that it adds to long-distance reception.

The simple device to be described in this article is a form of wavemeter, but, instead of being calibrated in wavelengths or on an arbitrary scale, has an indicating dial directly marked in the settings corresponding to each important European station with an "official" place in the medium broadcasting waveband. It is intended to be inserted in the aerial circuit, and will function satisfactorily with the great majority of receivers, irrespective of the type of tuning dial fitted. Exceptions are those with automatic volume control and a few others which include a series aerial condenser of extremely low capacity. For use with these sets a buzzer and dry battery may be added, as will be described later, without prejudice to the accuracy of the meter.

After careful consideration and comparative tests, the absorption method of obtaining an indication was adopted. The most obvious advantages are simplicity and cheapness, but there are other strong points. A buzzer wavemeter is noisy, and needs periodical adjustment and renewal of its battery; the absorption instrument, apart from requiring no maintenance, is silent in operation, giving its indication by reducing the loudness of incoming signals. As shown in Fig. 1, the Station Finder comprises nothing more than a tuned circuit—coil and variable condenser—with means for coupling it suitably to the aerial circuit.

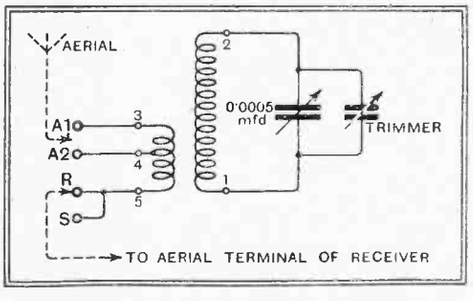


Fig. 1.—Complete circuit diagram; external connections to receiver in dotted lines.

Anyone with access to an accurate standard meter can construct and, given sufficient patience, can calibrate a station indicator, but special precautions have to be taken to ensure that an instrument that is virtually self-calibrating may be set up with the required degree of accuracy by the amateur without special facilities. An error of more than about one part in 200 will lead to ambiguity between stations; but the degree of accuracy implied is much easier of attainment than would appear, and the writer has made so many tests that he is convinced that no reader who is prepared to take reasonable care should fail to better this figure, as an average.

A great deal depends on the tuning condenser, and the Cyldon component specified is highly suitable for this particular purpose. Discrepancies between individual specimens have in no case been found to be greater than can be corrected by the simple method of adjustment to be described. As an additional safeguard, the makers have undertaken to supply, for use in building the Station Finder, condensers which follow the same law as the specimen used in making the original calibration.

Of almost equal importance is the tuning-coil assembly, of which the tuned section is wound with fifty turns of No. 22 D.C.C. wire on a 3in. paxolin former. The coupling coil, of six turns of No. 30 D.S.C. wire with a tapping at the fourth turn, is space-wound over one end of the tuned section. It is

Direct-reading Station Finder—

IT is natural that the majority of constructional articles should appeal only to a more or less limited number of readers. The Direct-Reading Station Finder, on the other hand, will be of interest to everyone who has a receiver capable of anything more than local-station reception. Although the device is so accurate as to ensure positive identification of practically any medium-wave European station, it may be built and operated successfully even by those with no previous experience of home construction.

obviously necessary that all coils should be matched to a standard, and so arrangements have been made with Tunewell Radio to produce suitable assemblies with inductance values within the prescribed limits.

Constructionally, there is not much difficulty in planning a layout for the few components needed, but care must be taken to see that the front panel is large enough for the station-indicating dial, which has a diameter of 7in. Although a plain square box would do as a container, a sloping front panel is more convenient, as it allows the dial to be read more easily. The Myers-Hunt cabinet specially designed for the Station Finder is supplied in parts, at the suggestion of the writer, so that the components may be fully accessible for assembly and

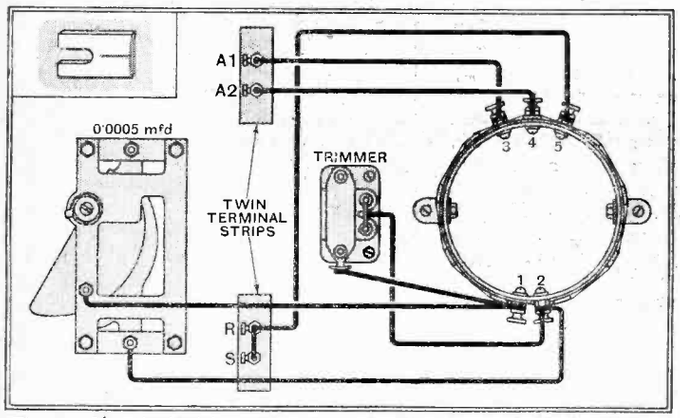


Fig. 2.—Practical wiring plan. Inset: a slip of cardboard, shaped and marked as shown, may be screwed to the front panel as a datum mark.

wiring, and thus avoiding the risk of damaging them, which is certainly increased when one is obliged to work in a restricted space. As shown in an accompanying photograph, all the parts may be mounted and wired with the base, front panel, and one side of the cabinet fitted together. Well-seasoned wood, which will not warp, is almost essential for the container.

Relative positions of the components are comparatively unimportant, but a minimum spacing of a full inch should be given between the coil and tuning condenser. Initial adjustment of the trimming condenser is effected by means of a screwdriver through a hole in the bottom of the box, and this component must be mounted so that its control screw-head registers with a hole of about $\frac{5}{16}$in. diameter, previously drilled. Mounting of the coil and variable condenser is quite straightforward.

Assembled and Wired in an Hour

Those who are accustomed to building sets will find the wiring ridiculously easy, as there are only eight connections to be made. The coil terminals are numbered to correspond with both the circuit diagram and the practical plan (Fig. 2), and there is consequently no risk of error. It should be noticed that the lower end of the tuned coil (terminal No. 1) is joined to the metal frame of the tuning condenser, and also to the springy vane of the trimming condenser.

To allow of better accessibility, the terminal strips through which connection is made to the unit are mounted on the front panel. That on the left-hand side carries sockets for connection of the aerial, marked A1 and A2, while the other, being blank, has been allotted arbitrary lettering; R corresponds to the socket through which connection is made to the aerial terminal of the receiver, and S indicates a short-circuiting socket. By inserting the aerial plug in this socket the station finder is thrown out of circuit entirely.

After having assembled and wired the components the indicating dial must be prepared. The semi-circular scale printed at the head of this article may be cut out and pasted on a disc of good quality pasteboard, about $\frac{1}{16}$in. thick and 7in. in diameter, with a hole of a full $\frac{1}{4}$in. in diameter through the centre. A 4in. tuning dial of conventional type is then mounted concentrically on the disc by means of Seccotine or similar adhesive; it is advisable to roughen the underside of the dial with sandpaper before glueing it. Plenty of time should be allowed for the adhesive to set thoroughly.

Instead of this improvised dial a more workmanlike and permanent job can be made by fitting one of the engraved ivorine discs which are being issued by the publishers of *The Wireless World*. One of these scales may be glued to a 4in. dial in the same way as a pasteboard disc; again, both surfaces should be roughened. Finally, the completed dial is secured to the spindle by means of the grub-screw, an indicating mark having previously been fixed to the panel. The zero mark on the dial should coincide with this indicator when the moving condenser vanes are fully out of mesh with the stator.

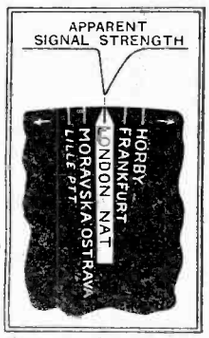
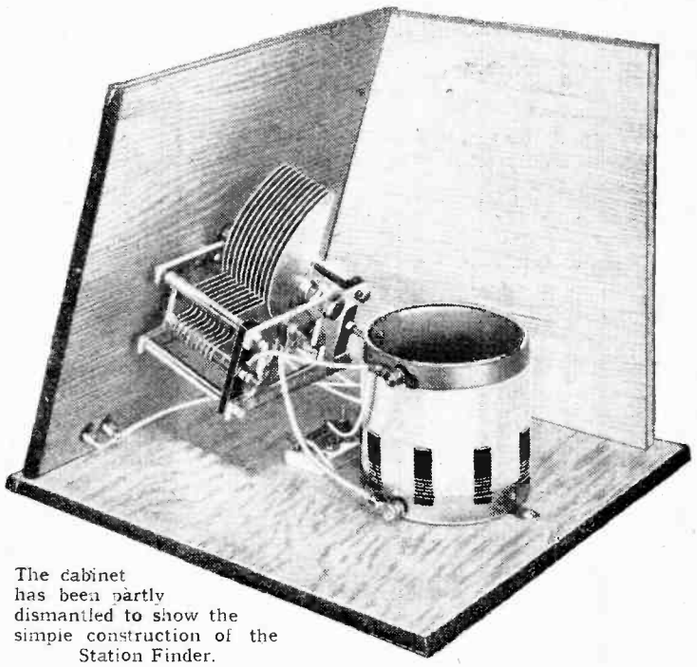


Fig 3.—Illustrating the asymmetrical effect of absorption.

We are now ready to start operations. Remove the aerial from the receiver and connect it to a plug inserted in socket A2. Join socket R to the aerial terminal of the receiver and make sure that absorption is taking place. With the set tuned to a transmission at about 250 metres rotate the station finder dial slowly until a point is reached where signal strength is reduced to a minimum; a little practice and it will be possible to determine the corresponding setting to within a small fraction of a degree. It should be noted that the "unders and overs" method should not be employed, as apparent signal strength usually varies asymmetrically about the point of resonance, rather as shown in Fig. 3. As the dial is steadily turned in one direction there is a sudden weakening, followed by a more gradual accession of strength to the normal level. Of course, a meter in the detector anode circuit is a useful aid to determining the correct tuning point, but is by no means essential.



The cabinet has been partly dismantled to show the simple construction of the Station Finder.

So far, station indications given by the dial will have no

Direct-reading Station Finder—

significance, as the operation of zero-adjusting has not yet been carried out. To do this, tune the receiver to a dependable station working on a wavelength of about 250 metres, and set the station finder dial accurately to the setting corresponding to that station. With a wooden-handled screwdriver adjust the trimming condenser for weakest signals without touching the dial; this operation should be carried out with patience and extreme care.

A check reading should now be made by tuning in another reliable known station at a much longer wavelength—say, about 500 metres. In order to get sufficient absorption it will generally be necessary to increase coupling by transferring the aerial plug to A1. If the name of the station being received is now accurately indicated on the dial—and with a modicum of luck it will be—all is well, and no further adjustment will be necessary; any station which adheres to its official wavelength may be identified with confidence. As a rule, use the A2 socket for stations under 300 metres and A1 for higher wavelengths.

How Accuracy is Ensured

If, on the other hand, there is a discrepancy at the top end of the tuning scale, a further operation is necessary. Irrespective of station indication, set the dial accurately for minimum signal strength on the longer-wave station, and then, without disturbing the position of the variable condenser vanes, slacken the condenser grub-screw and rotate the dial on its spindle so that it indicates accurately the name of the station. Secure the dial firmly again, and return to the shorter-wave station; a very slight readjustment of the trimming condenser will now be necessary.

For the benefit of readers who prefer not to use a cardboard indicating disc, an engraved ivorine scale for the Station Finder has been prepared. Applications for this scale, accompanied by a remittance of 2/- to cover the cost, should be made to our publishers, Iliffe and Sons Ltd., Dorset House, Tudor Street, London, E.C.4.

In some cases it may be necessary to repeat these operations several times, not forgetting to transfer the aerial coupling plug to the appropriate socket for the long- and short-wave station. At each repetition the discrepancy will become less.

It may be helpful to summarise these two zero-adjusting operations, which determine the accuracy of the instrument, although the second will seldom be needed.

(1) Set dial to name of short-wave station and adjust trimmer for minimum signal strength.

(2) Tune for minimum signal strength on long-wave station, and slip dial so that station name coincides with datum mark.

If occasion arises to repeat these operations they should always be done in the sequence given. Never adjust the trimmer at a long wavelength or slip the dial at a short one.

A specimen Station Finder is available for examination by readers at 116-117, *Fleet Street, London, E.C.*4.

LIST OF PARTS

1 Variable condenser, 0.0005 mfd. Log. mid-line	Cyldon, Type D5
1 Semi-variable condenser, 0.00007 max.	Cyldon, Type ST70
1 Special dial, 4in. diameter	Cyldon
1 Station Finder coil assembly	Tunewell
2 Twin socket strips, "A1, A2"; "blank."	Belling-Lee
1 Cabinet	Myers-Hunt Cabinet Co., Ltd.

Screws: 6 ¾in. No. 4 R/hd., 2 ½in. No. 6 R/hd.
Two lengths sleeving; 2 yds. No. 22 tinned copper wire.

DISTANT RECEPTION NOTES

THERE have been occasional slight atmospherics of late, but they have never been sufficiently serious to cause any real interference with long-distance reception. I notice, too, distinctly less spark signal interference, but heterodynes have unfortunately increased to some extent.

Stations affected recently by heterodyne interference are Lyons Doua, the Ecole Supérieure, Beromünster, the Poste Parisien, and Bratislava. The cause of the heterodyne on Beromünster is something of a mystery. When it first occurred some weeks ago it was supposed to have been caused by an unauthorised station working in Berlin. This was closed down by the authorities and the heterodyne ceased temporarily. Now, however, it is worse than ever, completely ruining the Swiss station's transmissions. According to the U.I.R. Report for November no fewer than three unknown stations were fairly regularly at work on wavelengths between those of Lyons and Beromünster.

The 20-kilowatt Italian station Bari, working on 269.8 metres, is often to be received, though the strength is not what one would expect, particularly when compared with that obtained from the 7-kilowatt Turin. Bari unfortunately shares a wavelength with the ½-kilowatt Bremen, and if both are working simultaneously there is distinct interference. The Athlone transmitter of the Dublin station appears to be at work, at intervals at any rate, though it would seem that it is not yet using full power, for the strength of the transmission is not greatly in excess of that of the old Dublin station on its good nights.

Transatlantic reception continues to be extraordinarily good. In addition to the U.S.A. stations it is frequently possible to hear transmissions from the Argentine, and I have once or twice picked up Mexican stations at very fair strength.

Of the long-wave European stations both Huizen and Kalundborg have shown a certain weakness on odd days recently. Motala, on the other hand, is improved, and I have from correspondents accounts of good reception from Reykjavik on 1,200 metres, though this is a station that very seldom comes in well in my own locality.

On the medium waveband there has been very little fading, even below 300 metres. Wavelength-wandering on the part of certain stations still continues to cause trouble towards the lower end of the band, but the number of stations in that region now receivable clear of serious interference is surprisingly good. Fécamp, in particular, is in excellent form. Both Nürnberg and Trieste are well heard. Gleiwitz varies somewhat, though good reception is usual. Turin is very much improved and is to be heard well on most evenings. Both Heilsberg and Hilversum are completely reliable, and Bordeaux has been coming through splendidly for some time.

Unhappy Neighbours

Genoa is seldom heard at better than moderate loud speaker strength. Göteborg is still not at its best; Breslau is well heard, but Milan and the Poste Parisien do not seem to be quite happy as next-door neighbours.

Brussels No. 2 and Strasbourg are always to be found. Hamburg is not constant, being occasionally very good, though sometimes quite poor. Toulouse has shown certain ups and downs. Some station, not positively identified, but probably Archangel, has caused occasional trouble with Leipzig, despite the latter's enormous strength.

Madrid Union Radio can be received, though not as a rule strongly; Berlin Witzleben, too, is not so strong as it was a week or two ago. Rome, Langenberg, and Prague have all been first rate. Florence shows a slight falling off, and Brussels No. 1 has sometimes been received at rather less than normal strength. Both Munich and Vienna have varied a good deal in strength, and Budapest, which until recently was generally receivable long before dark, has once or twice been weak late in the evening.

D. EXER.

FIELD WIRELESS IN N.Z. Amateur transmitters in New Zealand have formed a chain of portable stations for use in emergencies. The photograph shows Wellington amateurs assisting in the search for a wrecked aeroplane.

Practical HINTS and TIPS

AIDS TO BETTER RECEPTION

Rectifier Output Leads

A CERTAIN amount of care should be taken in arranging the leads which, in an A.C. set, connect the power rectifier to the reservoir condenser and smoothing apparatus. Of course, the need for adequate insulation has always been recognised, as the positive lead is at a high voltage with respect to earth.

Experience shows that, apart from the risk of insulation breakdown, there is a distinct risk of introducing hum if the leads in question are in inductive relationship with other leads and components in the receiver. The wave-form of the current flowing in these wires is such that troubles of this nature are particularly likely to be provoked.

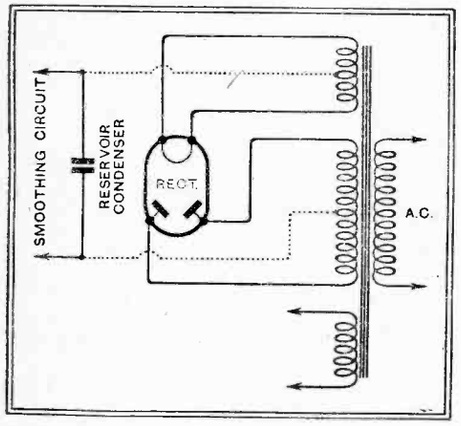


Fig. 1.—The rectifier output leads, shown in dotted lines, should be short and direct.

Fortunately, it generally happens that the rectifier, power transformer, and smoothing components are all mounted in close proximity to each other, and so the trouble does not often arise. But it is worth while bearing in mind, when a set is to be fed from a separate power supply unit that does not include smoothing equipment, that the reservoir condenser should be mounted close to the rectifier valve.

The two leads which are likely to give rise to induction troubles are shown in dotted lines in Fig. 1.

Parallel-fed Transformers

ONE of the advantages of feeding an L.F. coupling transformer through a resistance-capacity combination (instead of connecting the primary directly in the anode circuit of the preceding valve) is that bass response may be artificially "boosted." To do this, the value of the coupling condenser is so chosen that, in conjunction with the inductance of the primary, it will resonate at a very low frequency—towards the lower limit of audibility.

It sometimes happens that this state of affairs is brought about accidentally, perhaps by using for coupling purposes a condenser that happens to be available at the moment. In such cases all may be well, but there is a risk if the resonance happens to occur at about 100 cycles, that mains hum will be unduly accentuated and will be very difficult to eliminate by ordinary means.

The simplest remedy for the trouble is, of course, to use a different value of coupling condenser—generally larger than the original component, although sometimes a smaller capacity will be found to be actually better. This is largely a matter of trial and error.

Oscillator Reaction Adjustments

CONSIDERING the relatively large number of tuned circuits in the average superheterodyne, it is surprising that in most cases this class of receiver can be persuaded to function in an entirely satisfactory manner with a minimum of difficulty. The few difficulties that arise are, more often than not, associated with the oscillator valve or its circuits, and when results are not up to expectations, time may often be saved by devoting attention to this part of the set before looking elsewhere for the trouble.

Everyone knows that a superheterodyne receiver cannot work properly unless the valve in question is generating oscillations. But it is not so generally appreciated that results may be poor, at any rate over a section of the tuning scale, if it is oscillating too fiercely. This state of affairs is generally due to excessively tight coupling between plate and grid circuits, and it will sometimes manifest itself as a buzzing sound, audible in the loud speaker at certain settings of the tuning condenser.

When results are for any reason unsatisfactory, and particularly when the effect mentioned in the previous paragraph is noticed, it is worth while to assure oneself that the reaction winding of the oscillator coil assembly has not become displaced. This coil is sometimes wound on a small former, which is mounted inside the main former on which the grid and plate coils are supported. Even if buzzing does not take place, it is possible that general results may be improved by a slight alteration in the position of the coil; it must not, however, be moved to such an extent that self-oscillation ceases entirely at one end of the tuning scale.

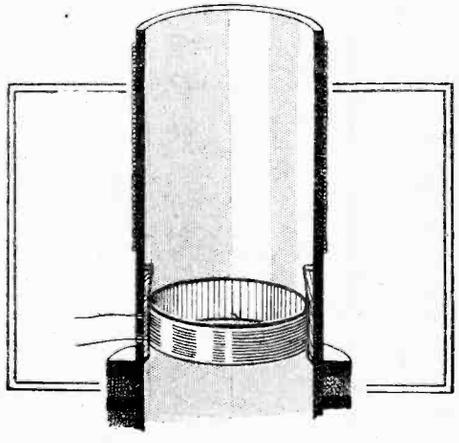
Adding a Reaction Coil

THE best-known property of reaction is to increase the strength of signals, but it has another application which is almost equally important. Properly used, it may be applied to increasing the selectivity of the set; the usual procedure is to reduce input either by loosening aerial coupling or by applying some other form of H.F. volume control, and then to make good the loss of signal strength thus brought about by increasing reaction.

This is an important application to many "2-H.F." sets that were designed a year or two ago. Many of these sets, now found to be insufficiently selective, do not include a reaction control. But even if the detector grid tuning coil does not embody a reaction winding it is generally a fairly easy matter to add one without structural alteration.

In most cases about thirty turns of fine wire—No. 36 D.S.C. is generally about right—will be sufficient for the purpose. As to the actual disposition of the extra winding, a good deal depends on the construction of the coils, and very often it will be possible to wind it in the form of a hank or piled winding. The best position will be such that the added coil is in inductive relationship with both medium- and long-wave windings. As a rule it should be rather nearer to the latter to give satisfactory control on both wavebands.

Where an external winding is not convenient it may be preferred to wind the reaction coil on a short length of tube, which may be inserted inside the main coil former in the manner shown in the accompanying sketch. The coil may be wedged



Fitting a reaction winding inside the former of an existing two-range coil.

in position by means of a couple of thin slips of wood; connections may be brought out through the wall of the main former, or passed through into the base, as may be most convenient.

Electrolytic Condensers

Their Properties and Uses

By PHILIP R. COURSEY, B.Sc., M.I.E.E.

(*Chief Engineer, the Dubilier Condenser Co., Ltd.*)

WHY have electrolytic condensers made their appearance in recent receiver designs? And what are the special properties and advantages of these over the more familiar mica or paper dielectric condensers? This article describes the construction of electrolytic condensers of various types and gives the reasons for their employment in special cases.

SINCE electrolytic condensers differ from all other types of condenser, not only in their construction but in their electrical properties as well, it is very desirable that all users of them should appreciate these differences and what they imply. It is true that electrolytic condensers possess certain features in common with other well known types of condenser (such as paper or mica dielectric ones) in that they have metallic electrodes, separated by a dielectric, and give a capacity effect expressible in microfarads; but the nature of the dielectric is so different that entirely different characteristics result therefrom.

How they Differ

In all other types of condenser, the dielectric is a separate and tractable material—e.g., a strip of paper, or a sheet of mica—and it is assembled with the metallic strips or plates forming the electrodes or armatures of the condenser. In electrolytic condensers the dielectric is too thin and delicate to be able to be dealt with separately (even supposing that it could be manufactured in a separate form). It is produced by an electrochemical or electrolytic process on the surface of the metal sheet or plate that forms one of the electrodes of the finished condenser. This alone might justify its name of electrolytic condenser, distinguishing it from other types; but the difference extends farther, in that an electrically conducting liquid, or electrolyte, is still required to complete the condenser in order to provide an electrical contact or connection to the outer surface of the electrochemically prepared dielectric film. Fig. 1 may make the distinction clearer. Fig. 1 (a) is intended to represent a single layer or plate of an ordinary condenser, M1 being one of the metal electrodes and M2 the other. Between them, and as closely as possible in contact with both of them, is the dielectric sheet D, which may, for example, be mica or paper, while any minute interstices between the adjacent surfaces are usually filled with some filling or "impregnating" medium, such as paraffin wax or oil. In Fig. 1 (b), the main metallic electrode of the condenser is indicated at M1 on the surfaces of which have been "formed" the electrochemically produced dielectric layer D1 D2, closely adhering to it. Outside this layer is disposed the other metal electrode of the condenser, designated by M2 M2', and shown in two parts for the purposes of the diagram. This electrode M2 M2', even if pressed up closely to the surface of the dielectric film D1 D2, would be likely to touch it in a few places only, giving a very poor capacity; so that the space between is filled with the working electrolyte E E. This is a conducting material, liquid, paste or solid, and by making close contact with the whole surface of the dielectric layer D1 D2, provides a good connection between it and the second metal electrode of the condenser M2 M2'.

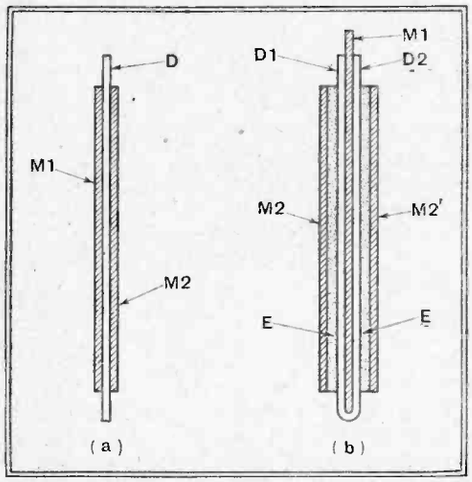


Fig. 1.—Comparison of structure of electrolytic with ordinary condensers.

The function of the electrolyte does not, however, end here. It would, if a perfect dielectric film could be prepared, but for various reasons these dielectric coatings are more or less pervious. They have minute holes or perforations—perhaps only of molecular dimensions, but sufficient to permit the passage of a considerable current through them, and so produce practically a short-circuit between the metal electrodes. The passage of the current, however, through the electrolyte decomposes it to some extent, liberating minute gas bubbles in the dielectric perforations and so largely sealing them against the passage of further current; or, provided that the electrolyte contains the appropriate chemicals, actually forming new dielectric film on the surface of the main metal electrode, and so more or less filling up the perforations. These actions of the electrolyte are quite as important as the contact making action, first mentioned, and contribute largely to the successful working of the complete condenser.

Polarised Condensers

In paper and mica dielectric condensers, the nature of the metal used for the electrodes plays only a very secondary part; in electrolytic condensers it is all important, since the essential dielectric film can be formed easily only on certain metals. Of the common metals, aluminium is the most suitable in this respect, and is the one used in commercial electrolytic condensers.

The dielectric film is produced on the aluminium electrode by electrochemical treatment in a solution such that oxidation of the metal takes place. The dielectric film thus consists mainly of aluminium oxide. The dielectric strength of these films—that is to say, the voltage that they will stand up to when made up into a finished condenser—is determined by the thickness of the film and its physical structure, factors which are both controlled by the nature of the electrolyte in which the formation of the film takes place, as well as by the details of the electrochemical forming treatment.

In the completed condenser the aluminium electrode upon which the dielectric film has been formed *must always form the positive pole of the condenser.* Electro-

Electrolytic Condensers—

lytic condensers are polarised, and in general terms, therefore, they are only suitable for use in circuits where they are subjected to unidirectional voltages, so that the current through them is not reversed. In Fig. 1 (b) the electrode M1 must always be positive, while the second electrode M2, which has no dielectric coating on it, is the negative.

Electrolytic condensers are fundamentally different from other condensers in this respect. Since for the reasons already stated the working electrolyte between the metal electrodes in the finished condenser contains some chemi-

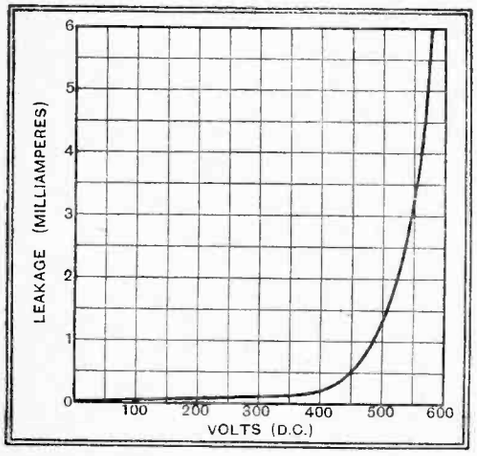


Fig. 2.—Voltage characteristic of electrolytic condenser.

cal materials which can continue the oxidising or forming action on the dielectric film by the small leakage current flowing through the condenser, it follows that the correct polarity of the terminals of these condensers must always scrupulously be observed. Otherwise the dielectric coating will tend to go into solution in the electrolyte and so be destroyed; while at the same time the vigorous electrolytic action accompanying the comparatively large current which would pass in the reverse direction would liberate a quantity of gas, the pressure of which might fracture the condenser container.

Leakage Current

Another important feature wherein electrolytic condensers exhibit abnormal properties as compared with other condensers is to be found in the leakage current which is always flowing through them when they are in use. This current, although small in value, is vastly greater than the minute leakage current which flows through the insulation of a paper or mica dielectric condenser. Electrolytic condensers *have no insulation resistance in the usually accepted sense* of the expression. Actually, of course, the dielectric film of these condensers has a resistance amounting to perhaps 2 megohms in the case of a standard 8 microfarad 450-volt condenser—a value equivalent to an "insulation resistance" of 16 megohm-microfarads, compared with which the corresponding figure for a good paper condenser of some thousands of megohm-microfarads is of an entirely different order. Furthermore, this figure is not a constant, but varies widely with the voltage applied to the condenser terminals, since the leakage current is very minute for low voltages, rising rapidly as the voltage is increased beyond the rated value for the condenser. The mode of this variation for a typical condenser is depicted in Fig. 2, while Fig. 3 gives the corresponding figures of so-called "insulation resistance."

The shapes of these curves indicate further another feature in which electrolytic condensers differ from paper or mica dielectric types. With the latter types of condensers the voltage applied to them can be increased up to a certain critical figure—the breakdown voltage—when sudden puncture of the dielectric occurs; with electrolytic condensers, on the other hand, the value of the leakage current gives a very fair indication of the nearness or otherwise to the maximum limiting voltage that may be applied to the condenser. Examining Fig. 2, it is seen that as the voltage is raised, the leakage current increases slowly at first, and then more and more rapidly. The larger increase generally determines the safe maximum voltage. The reason for this is mainly a thermal one—when the leakage current becomes large, the energy loss in the condenser and the consequent heating occasioned thereby also becomes large. This generally results in a further increase in leakage current and the operating conditions then become unstable until failure of the condenser occurs.

Electrolytic condensers show a measure of self-sealing effect, so that the failure of such condensers under excessive voltage may take several forms depending upon the particular construction given to the condenser. Some of these condensers — the so-called "wet" types — have very fluid electrolytes, made usually of an aqueous solution of some salt or salts; others—the semi-dry type—have a thick viscous paste-like electrolyte; while still others—the "solid dry" type—have a hard, solid electrolyte. With the first type, excessive voltage punctures the dielectric film, and audible sparking takes place under the liquid. This causes heating and rapid evaporation of the liquid, both by the heat and the electrolytic action of the large leakage current. With the second type, excessive voltage produces ultimately charring of the mechanical spacer (cloth or paper) between the plates, by excessive local heating. Puncture of the film may also take place, liberating gas, which will usually in such cases mechanically separate the plates by its sudden liberation, and so prevent them from producing a short circuit. A momentary overload will thus reseal, much as with the wet type; but a maintained overload will likewise destroy the condenser by the overheating. With the third type, excessive voltage generally produces a much more sudden puncture much resembling that of the more ordinary condensers.

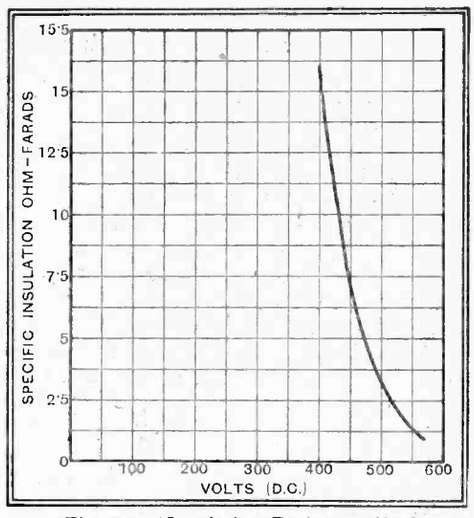


Fig. 3.—"Insulation Resistance" of electrolytic condenser.

The increase in the leakage current that occurs with excessive voltage acts as a certain measure of protection for the condensers when they are used in radio receivers, as the increased load on the rectifier will tend usually to keep the voltage rise down; but even so, thermal damage may still result if the overload persists.

Electrolytic condensers differ from the more ordinary types of condenser in being operated usually at a voltage very much nearer the limiting value than is the case with paper or mica. With the latter, a ratio between the limiting puncture voltage and the working voltage of at least 5 to 6 is generally desirable; while with the former a value round about 1.2 to 1.5 is seldom exceeded. There is, therefore, with electrolytic condensers much less margin of safety to deal with voltage variations due to adjustments or other causes, which may or may not be under the control of the user of the radio set in which they are incorporated.

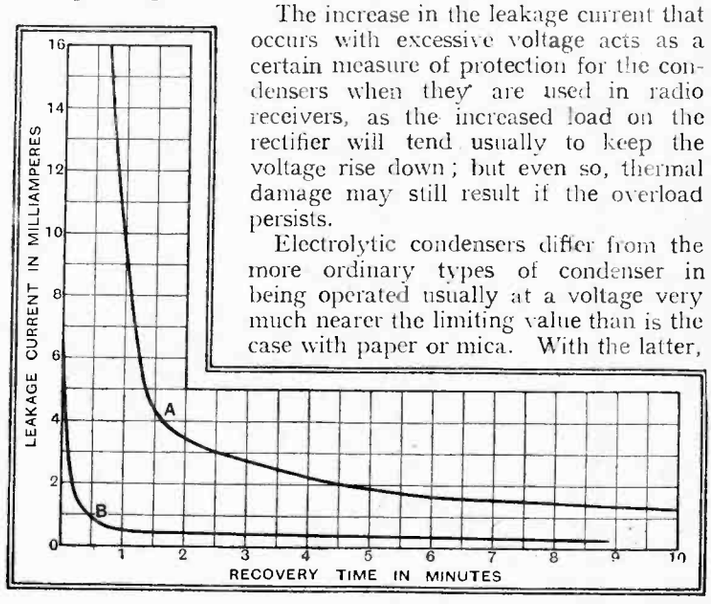


Fig. 4.—Recovery curves for electrolytic condensers, plotted from tests on commercial condensers. Curve A shows poor, and curve B good recovery or "reforming" time.

Electrolytic Condensers—

Still another feature in which electrolytic condensers differ from others shows up in their quantitative electrical properties as their "power factor." The electrolyte is, from its nature, not a perfect conductor, but it possesses a certain resistance to the flow of current through it. With the wet types this resistance is usually fairly considerable, but with the drier types the very much closer spacing of the electrodes brings with it a considerably lower resistance value. The flow of alternating, or ripple current, through this resistance is necessarily accompanied by a loss of energy as heat, which is generally expressed numerically by the power factor. For the dry types a power factor of 5 per cent. to 10 per cent. is possible; while for the wet types it may reach values as high as 25 per cent. to 30 per cent. The value of the power factor sets the limit to the maximum permissible ripple voltage which may be superimposed upon the normal d.c. voltage of the condenser without causing overheating and damage. Manufacturers of these condensers usually specify this limiting figure —which depends upon the particular form of their condensers.

Intimately connected with this value of power factor is the effective value of the capacity of the condenser and the manner in which it changes with variations in the frequency of the ripple voltage. The series resistance of the electrolyte reduces the effective capacity of the condenser to alternating currents; and as these condensers are customarily used for smoothing rectified alternating currents, the effective a.c. capacity is the only one with which the user is really concerned. This value in microfarads is generally measured and quoted at 50 cycles, and with condensers having a small power factor the change between 50 cycles and 100 cycles (which is the normal ripple frequency for double wave rectification) is negligible. With high power factor condensers the difference becomes more important.

Pronounced Absorption Effect

Finally, another point of peculiarity of these condensers resides in the degree of stability of the dielectric itself as compared with, say, paper or mica. With these latter no changes in the condenser should take place when the condenser is standing idle, unused, or with no voltage applied to it. With electrolytic condensers some changes often occur under these conditions; but the trend of research and development is in the direction of eliminating these changes. When an electrolytic condenser has been standing idle, and a d.c. voltage is suddenly applied to its terminals, there is an initial rush of charging current just as there is with any condenser; but this current does not immediately disappear, but only gradually decreases to the normal leakage value. This effect is analogous to the so-called "absorption" found with paper and mica condensers, but is much more pronounced. With the best types of electrolytic condenser this abnormal leakage current is finished for all practical purposes in a fraction of a minute, but with the older types it persisted for much longer periods. Typical values are shown by the curves in Fig. 4.

Summarising the chief points regarding electrolytic condensers and the merits of their use, it appears that their sole advantages lie in their small size for a given microfarad capacity, and consequent lower cost; while the attendant disadvantages are to be found in their peculiar properties, which, as indicated above, require special consideration in the practical use of the condensers. These special properties almost limit their use to the smoothing of d.c. circuits, with a comparatively small superimposed a.c. ripple voltage. In general, the design of these condensers must of necessity be a compromise between the effects of conflicting properties and requirements, and taking everything into consideration the best compromise is probably found in those types having the "semi-dry" or paste-like electrolytes, which give a good all-round performance, while avoiding the special disadvantages associated with the extremes of both the wet and the super-dry types.

In Next Week's Issue:—

THE QUIESCENT PUSH-PULL TWO

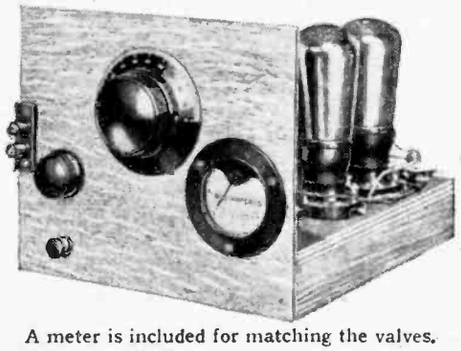
A Two-stage Local Station Battery Set giving Generous Moving-coil Output with a Total Working H.T. Consumption of 8 mA.

THIS striking receiver, embodying the principles outlined in last week's issue under the title "Outstanding Battery Set Development," comprises a detector coupled by a high-ratio transformer to two Pen.220A valves in quiescent push-pull. The output delivered to the moving-coil speaker, either from radio or gramophone, reaches the remarkable figure of about 1½ watts speech, although the H.T. battery used is only of the smallest type. Thus the listener without access to electric supply mains is now able to enjoy the volume and quality of reproduction hitherto regarded as the prerogative of the mains user. The new development gives all listeners an equal opportunity to obtain reproduction and a volume-level constituting a lifelike representation of the original.

LIST OF PARTS

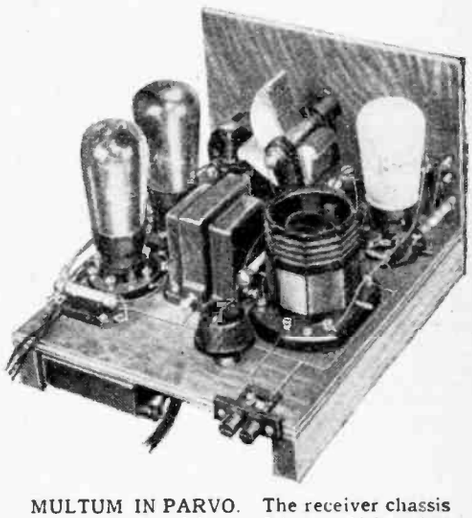
After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Slow motion variable condenser, 0.0005 mfd. — Formo No. 10C
1 Intervalve L.F. transformer, 9:1 (Multitone, Ferranti, R.I.) — Sound Sales SS/PP9
1 Dual range coil (Lissen) — Colvern RM2S
1 Milliammeter, 0-10, moving iron — Sifam E66
1 On-off switch, with clips for meter — Benjamin Type B
3 Valve holders, 5-pin — Junit



A meter is included for matching the valves.

1 Potentiometer, 25,000 ohms — Rotorohm
1 Pair G.B. battery clips — Gripso
1 Switch, 8-pt. — Telsen
1 H.F. choke — McMichael Binocular Junior
1 Reaction condenser, 0.0003 mfd. — Polar "Compax"
2 Twin socket strips, aerial, earth, 2 pick-ups — Belling-Lee
1 Grid leak, 1 megohm — Dubilier
1 Metallised resistance, 5,000 ohms, 1 watt — Dubilier
1 Metallised resistance, 20,000 ohms, 1 watt — Dubilier
1 Metallised resistance, 75,000 ohms, 1 watt — Dubilier
1 Metallised resistance, 150,000 ohms, 1 watt — Dubilier



MULTUM IN PARVO. The receiver chassis measures only 9½ ins. × 8 ins. × 6½ ins., but the output is equal to that from a mains set.

1 Fixed condenser, 0.005 mfd. — Dubilier No. 670
1 Fixed condenser, 0.0001 mfd. — Dubilier No. 665
1 Fixed condenser, 0.0003 mfd. — Dubilier No. 665
1 Fixed condenser, 1 mfd., 250 volts, D.C. working — Peak
1 Fixed Condenser, 2 mfds., 250 volts, D.C. working — Peak
3 Wander plugs, Grid+, Grid−, Grid− — Belling-Lee "Bow Spring"
1 Battery cable, 6-way, 30 ins. — Belling-Lee
1 G.B. battery, 16½ volts
1 H.T. battery, 130 volts — Drydex Special Quiescent Push-pull, Yellow Triangle
1 Loud speaker, with transformer — Celestion QPT19A
Cabinet with wood panel, baseboard and battens — Clarion Radio Furniture, 28/38, Mansford Street, Hackney, E.2.

Systoflex, 1 oz. No. 22 tinned copper wire, etc.
Screws, 12 ¼in. No. 4 R/hd., 8 ¾in. No. 4 R/hd., 6 ¾in. No. 4 R/hd., 4 ¾in. No. 4 C/sk., 2 ¾in. No. 6 C/sk.
Valves, 2 Mazda Pen.220A, 1 Mazda H.L.2 metallised.

UNBIASED

By

FREE GRID

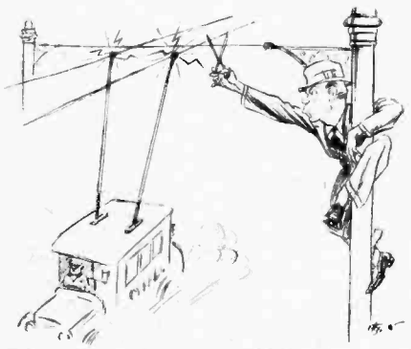
Simple and Good

GADGETS have always been a source of delight to me, but I must confess that when the Editor posted to me an advance model of *The Wireless World* Station Finder I was rather dubious, having been stung more than once by so-called station locators and patent tuning charts of the jig-saw-puzzle variety.

A few minutes' handling of the instrument speedily reassured me, however. To my mind, the great thing about it is its simplicity, there being no need for Bradshavian juggling with calibration charts and lists of stations; even Aunt Agatha, with all her adroitness in these matters, would find it a difficult task to mess it up.

Is the Menace Real?

I OFTEN wonder what is the real truth about the great trolley-bus menace to radio reception, as such conflicting reports seem to come from people who



Averting the trolley bus menace.

dwell near roads over which these juggernauts run.

On the one hand, I read that it is quite easy for interference to be completely eliminated and, incidentally, that this has been done by the Southend-on-Sea Corporation; yet, on the other hand, according to a well-known East Anglian journal, "very exhaustive tests were made in Ipswich about a month ago when it was admitted by the Post Office and the B.B.C. officials that there was no known method of eliminating these disturbances."

Are the Gippesvicensian engineers incompetent, or can it be that the trouble has not yet been so completely eliminated in Southend as we are led to believe? Perhaps I shall be able to get an answer to this question at the Southend Radio Show, which I hope to visit on the 28th of this month.

Set Tracking at Speed

ACCORDING to one of the oldest of our weekly journals, the Post Office are now using a special detector van capable of doing its stuff while travelling at over seventy miles an hour, the idea being to detect the presence of unlicensed sets used in cars.

If the report be true, a wicked waste of public money is entailed. Cannot an ordinary detector van deal with the cars when they are in their garages? For the purpose of detection it does not matter in the least whether sets are being operated or not. The idea of providing a special high-powered van is rather Gilbertian and reminds me of the man who, having cut a hole in his study door so that his cat could come in without disturbing him, afterwards made four additional small holes for its quartet of kittens.

Grave Form of Static

IT is well known among old listeners that in the early days of broadcasting a considerable amount of local interference was experienced from electrical machinery installed in cinemas. In fairness to the managers and proprietors of these establishments, I must place it on record that in most cases, when a complaint was made, they went to considerable trouble and expense in getting remedial measures applied to their machines by a competent firm of electrical engineers.

Since those days, however, what Kipling calls "a baser breed without the law" seems to have arisen among the ranks of these gentry. Possibly the coming of the talkies has had something to do with it.

Let a few facts speak for themselves. A friend in a small country town recently asked me to diagnose the cause of certain interference with radio reception which was troubling not only him but a great many of his neighbours. My investigations leading me to believe that the trouble was coming from the local sob-stuff saloon, I hoped that a tactful interview with the manager would speedily put matters right. But before the interview took place I made the disturbing discovery that the interference was being deliberately manufactured in order to drive local yokels from the solid comforts

Disturbing discovery.

Suspected!

of the fireside to the more exotic delights of the "hot house." It appears that the owner-manager of the little tin shack that does duty for a cinema, realising that radio was gradually weaning his patrons away from his pestiferous picture palace, had hit upon this plan of driving them back again, fully realising, of course, that the law could not touch him.

If this sort of thing is allowed to go on unchecked it will not be long before the proprietors of tea-shops, art galleries, and museums adopt similar tactics, and pandemonium will be let loose.

Although I am preparing a full report for presentation to the proper quarter, a little publicity here and now may scotch this snake in the grass.

The Old Geyser

IT would, to say the least, be boorish and unmannerly of me if I failed to give thanks in these columns to the many public-spirited citizens who responded to my appeal for assistance in a recent delicate mission. It will be remembered that it fell to me to make tactful representations to an old "geezer," whose practice it was to take power for her bath geyser from the 105 volts local electricity supply at an hour in the evening which was distinctly inconvenient to owners of mains radio sets. Advice came, not only from this country, but even from the Continent.

Readers will be pleased to learn, however, that I was spared the necessity of approaching the lady by a purely coincidental action on the part of the local Electric Supply Company, who suddenly decided to change the local voltage from 105 to 240. As the more advanced of my technical readers know, this action in itself, by more than halving the current, will do a like service to the voltage drop along the lengthy feeder line. Quite apart from this, however, the Electric Supply Authorities are endeavouring to persuade her to change her geyser for a modern electric thermal storage tank. I understand that, owing to the heavy and fitful loading which electric geysers impose on the line, they are not looked upon with favour by Electric Supply Authorities.

Thank You

I SHOULD like to take this opportunity to give somewhat belated thanks to all those readers who have been so kind in sending me little tokens of their esteem during this festive season. I have now enough hand-knitted bed-socks to last me for several years.

News *of the* Week

Current Events in Brief Review

More Kilowatts

BERLIN'S new 120-kW. broadcasting station, replacing Witzleben, is expected to make its first bow in the early summer.

Joking at 7.30 a.m.

POSTE Parisien is arranging morning broadcasts between 7.30 and 9 o'clock consisting of news, physical training, jokes and gramophone records. Listeners' suggestions should be sent to 116, Ave des Champs Elysées, Paris.

Dentist v. Decibels

A CREWE dentist, complaining to the Town Council in regard to a noisy loud speaker, said that he had sometimes to wait till the noise stopped before administering an anæsthetic, as it was impossible to hear whether the patient was breathing or not.

House Builders and Man-made Static

THE French semi-official newspaper, *Le Temps*, publishes an article by M. Jacques Pipoul in which house builders are appealed to on behalf of radio listeners. "All specifications for new houses, remarks the writer, should include provision for anti-static devices so that tenants can listen in comfort without disturbance from lift motors, electric bells, and the other usual sources of interference.

Mr. G. S. Kemp

MR. G. S. KEMP, who was Marchese Marconi's first assistant when the young inventor came to England in 1896, has died at the age of seventy-six. A familiar figure at Marconi House until quite recently, Mr. Kemp had completed over thirty-five years of service with the company. It was in December, 1901, that he accompanied Marconi to St. John's, Newfoundland, and heard the historic first radio signals across the Atlantic, transmitted from Poldhu, Cornwall.

Railway Time by Radio

TWO hundred railway clocks on the French State Railways around Rouen are set daily by wireless from the Eiffel Tower. The master receiver at Rouen station is operated by a mercury relay which switches it off just before the morning time signal.

Scope for Radio Architects

BRUSSELS architects are being invited to submit designs for the projected "Broadcasting House" to be occupied by the Belgian National Radio Institute at Ixelle, on the outskirts of the city. The present headquarters are in a private house, and the main studio is an old dance hall.

U.S. Broadcasting Flourishing

DESPITE business depression in America, as elsewhere, the National Broadcasting Company and the Columbia Broadcasting System both report record revenues for eleven months of 1932. Up to November the two organisations had together profited to the extent of $36,101,093, as compared with $35,791,999 for the whole of 1931.

The Listening Age

THE majority of wireless listeners are between the ages of thirty and fifty, according to the investigations of the Austrian broadcasting authorities, who recently initiated a voluntary census. Fifty per cent. of listeners are middle-aged, some 25 per cent. are classified as "old" (over fifty?), and 20 per cent. young.

These figures, as a correspondent points out, are valid only for 1933. Very soon all baby carriages will be equipped with receivers, and children may eventually be born wearing natural headphones.

A Popular Deputy

A FRENCH deputy has advanced the following reasons for voting against the proposed radio listening tax:—

(1) It would be too difficult to discover all the owners of wireless sets. (2) This "lamentable" tax would put a stop to the wireless business, as listeners would dread, rightly or wrongly, that their addresses would be communicated to traders. (3) The set would be flung into the corner and family groups around the loud speaker would become a memory of the past.

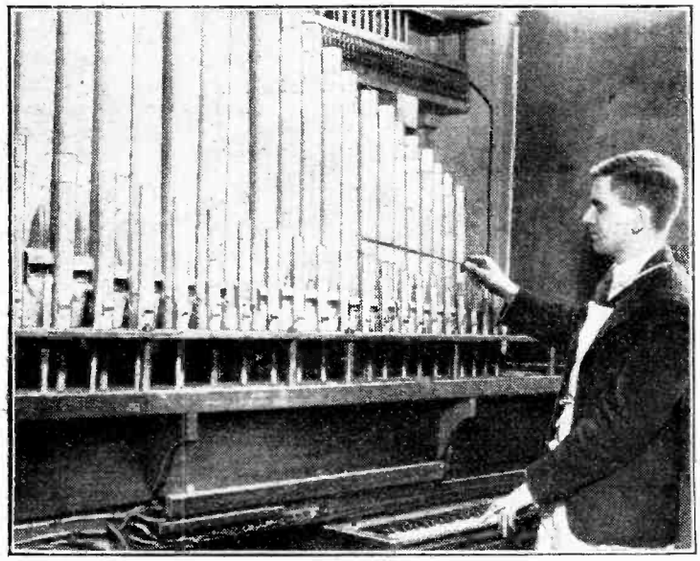
Happy Amateurs

WHATEVER other interests may have suffered or failed to find satisfaction at the recent Madrid Conference, the amateur transmitters did well. Opposition to the amateur movement was offered by several nations, but a coalition of the English-speaking countries overcame all threats.

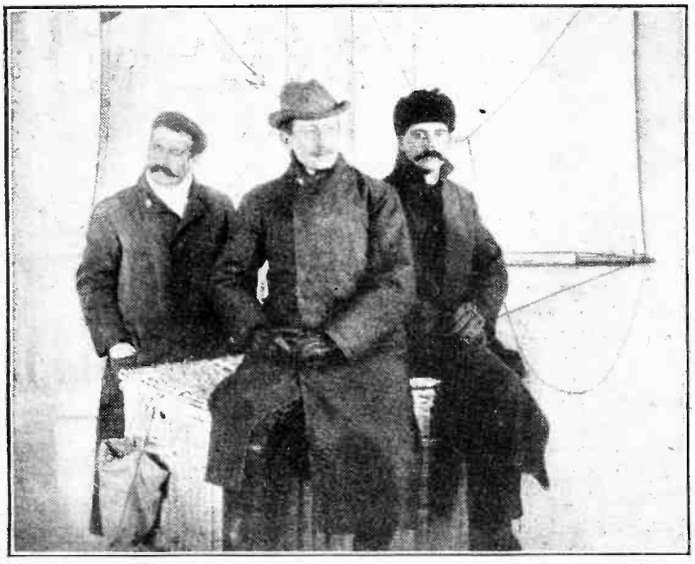
Major Kenneth B. Warner, Chairman of the amateur delegations, has gratefully acknowledged the support of the United States, British and Canadian delegations, assisted by British Honduras.

Radio for London Police

ST. ANNE'S ROAD (Tottenham) Police Station, which will probably be one of the three new Metropolitan police wireless centres, was the scene of a special demonstration during the night of January 3rd and 4th, when telephony messages radiated from a station erected by an R.A.F. wireless section were picked up in cars at such places as Potters Bar, Barnet, South Mimms, Elstree, Hampstead and Hendon.



AN ORGAN FOR BROADCASTING.—Voicing the pipes of the new £10,000 instrument for erection in the Concert Studio at Broadcasting House. The organ, which includes 2,326 pipes, is being built by the John Compton Organ Company.



AN HISTORIC GROUP.—The death of Mr. G. S. Kemp (seen on left) recalls the famous occasion at St. John's, Newfoundland, in 1901, when the young Marconi (seated in front) succeeded in picking up signals from Carnarvon on a kite aerial, his assistants being Messrs. Kemp and Paget.

That Empty Inch

A FEW days ago the head office of "His Master's Voice" received a telephone message from a lady who complained that there was an inch of space at the end of a recently purchased twelve-inch record. After it had been explained to her that the piece recorded had been too long for a ten-inch record, she expressed regret that in these days of economy the remaining inch had not been filled up with music, and enquired whether she could return the record for this to be done.

Storm in a Teashop.

SOME time ago, according to a correspondent in Japan, a well-known tea shop in Kioto was infested with a plague of flies, and the proprietor, being of an inventive turn of mind, got rid of them by steaming the shop with two separate jets of steam from boiling kettles attached by wires to the anode and cathode respectively of a battery. One cloud of steam laden with a positive charge came into collision with the opposite cloud negatively laden, and there ensued a miniature thunderstorm, which electrocuted the flies.

Less Education in German Ether

GERMANY'S educational broadcasting concern, the *Deutsche Welle*, ceased to exist at midnight on December 31st. This organisation made use of the Konigswusterhausen transmitter daily until 8 p.m., and dealt almost exclusively in educational transmission. Its successor, the Deutschlandsender G.m.b.H., is responsible for all programmes from Konigswusterhausen, and these, we learn, are to be less educational in character. The new station call is "Hier ist der Deutschlandsender Konigswusterhausen."

High-voltage Valves

MR. EUGEN FORBAT, British representative for the Ostar Ganz high-voltage valves described in our issue of December 23rd, 1931, will lecture on the valves at a meeting of the Bristol and District Radio and Television Society on January 20th, at 7.30 p.m.

Practical Automatic Volume Control

The Square-law System

(Concluded from page 4 of last week's issue)

By W. T. COCKING

LAST week's article concluded with a comparison of methods of automatic volume control, and, since it would appear that the square-law type of control is more suited to our present purpose of adding A.V.C. to an existing set, let us see how we can do this in the case of a receiver of the type described at the beginning of last week's article. The receiver chosen, it will be remembered, was a modern superheterodyne with a variable-mu H.F. stage, screen-grid first detector, variable-mu I.F. stage, and with a potentiometer volume control regulating the bias of both variable-mu valves.

The detector input will now be only about 1 volt, so that it is possible to control the I.F. valve, for an output of this order can readily be obtained from a variable-mu valve at a high bias voltage.

The anode-bend detector is perhaps the nearest practical approach to a square-law rectifier, and it is ideally suited for bias

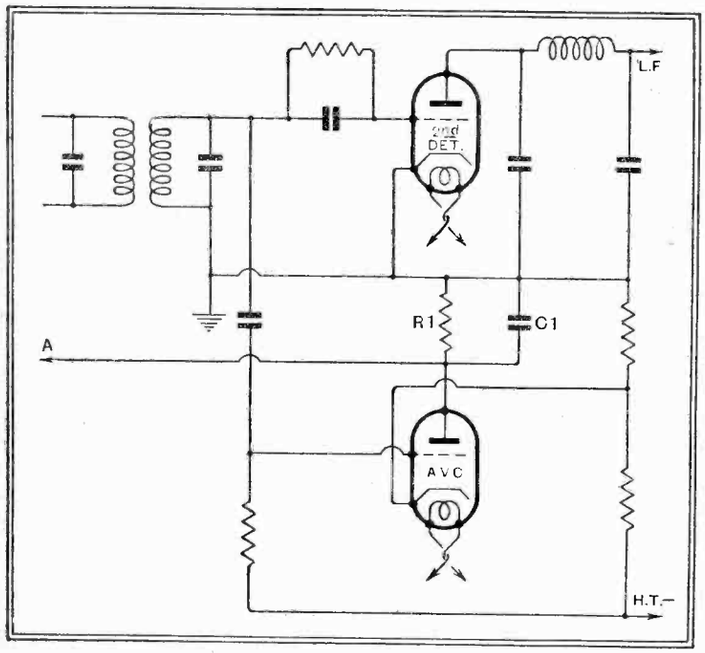


Fig. 6.—The simplest connections for a square-law type of control are apparent. The time constant depends upon the values of R1 and C1, as well as upon those used in the decoupling circuit.

control if the circuit be arranged in a similar manner to Fig. 6. It will be seen that the detector proper is of the normal distortionless power-grid type, while a separate anode-bend detector is used for the provision of grid bias. In the absence of a signal the cathode of the control valve is biased positively, which means that its grid is biased negatively, by the tapping on the potentiometer, to the point at which anode current just ceases to flow in the control valve or to a point slightly more positive. The grid circuits of the controlled valves are returned to earth through a resistance, which acts as the load on the A.V.C. valve. As no current flows through this resistance there is no voltage drop across it, and the bias is only the fixed minimum provided by other means for the H.F. valves.

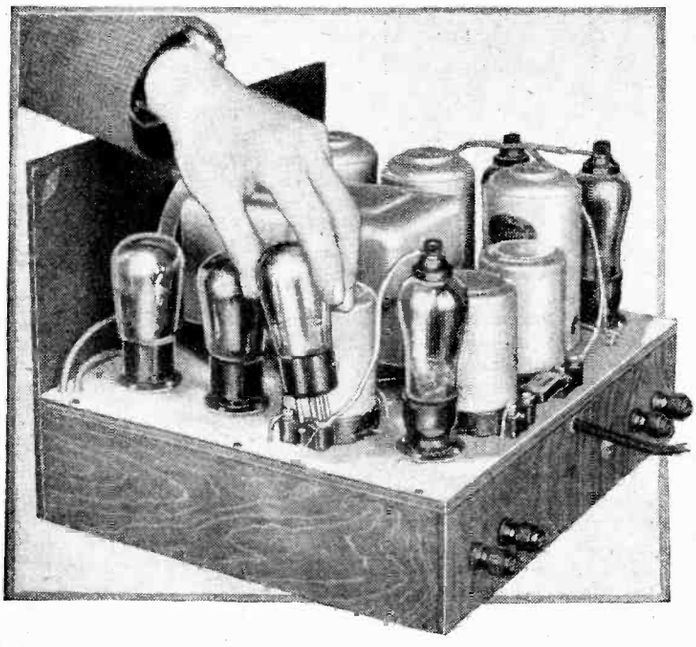
Delayed Action

When a signal is applied to the control valve it is rectified, and anode current flows in the control valve. This current is more or less proportional to the square of the input, and flows through the resistance R1. As a result, there is a voltage drop across R1 which is directly proportional to the current, and which is in such a direction that the anode becomes more negative than the earth line. This voltage is applied directly, through the usual filters, from the point "A" to the grids of the controlled valves as grid bias. By applying such a value of initial bias to the control valve that anode current does not flow until a certain signal input has been reached, the delayed action described for certain special diode connections can be readily obtained.

One of the advantages of this type of control lies in the fact that little alteration to the fundamental design of a receiver is necessary, for no limitation as to the use of tone correction is imposed. A high H.T. voltage is required, however, for the control valve needs a supply of some 50 to 100 volts, and this must be obtained in series with the supply for the controlled valves. In most cases this means a total supply of some 250 to 300 volts. Where provision is made for feeding the field winding of a loud speaker from the mains equipment, however, it will often be possible to employ the voltage drop across the field for operating the control valve. A further disadvantage lies in the fact that it is usually unwise to run the heater of the control valve from the same filament transformer winding as the other valves.

IN the first part of this article the use of the Double Diode valve for automatic volume control was discussed, and the author explained how the valve could be used in a modern receiver. In the present article an alternative method of A.V.C., known as the Square-law System, is explained, and the reader is shown how to apply it to existing sets.

The arrangement of Fig. 6 is usually employed in America with an anode-bend detector for the normal demodulation, instead of a power-grid type as shown. For good operation the control valve requires an input of some 5 to 10 volts on a local station, and an anode-bend detector also works best with about this value of input. Where both valves work on the anode-bend principle, therefore, the arrangement of Fig. 6 is entirely satisfactory. With a power-grid detector as a demodulator, however, it will often happen that the detector overloads before the full control is estab-



With the square-law A.V.C. system little alteration to the fundamental design of the receiver is necessary.

Practical Automatic Volume Control—

lished, for the normal power-grid detector input is only some 1 or 2 volts.

A solution would obviously be to provide the control valve with an additional stage of amplification, but this is hardly practicable on account of the expense. It is well known, however, that the H.F. input to a detector appears also in the anode circuit, due to the normal amplifying action of the valve. In normal design we try to keep this anode circuit H.F. as small as possible by using a large-capacity anode-cathode by-pass condenser. Suppose, however, that we turn this normally unwanted amplifying action into account, and make the valve amplify, not only the L.F. potentials developed in the grid circuit as a result of rectification, but also the impressed H.F. signal. We can then feed the control valve from the detector-anode circuit with amplified H.F. potentials without using additional apparatus, and we should avoid the difficulty of detector overloading.

This may readily be done by making the detector load impedance high at the input frequency, and the simplest method of arranging this consists in the omission of the anode-cathode by-pass condenser and the choice of a suitable H.F. choke for the usual filter circuit. This arrangement, as applied to a complete receiver, is outlined in Fig. 7, and it may be said that in practice it has proved extremely effective. The only disadvantage of the arrangement appears to be that the tuned input circuit of the detector is more heavily damped than usual; but, as the damping in a superheterodyne is normally fairly heavy, this is of little moment.

With a receiver of the type shown, it has proved possible to obtain such a degree of control that the audible volume from the loud speaker from the local station at a distance of only nine miles is no greater than that given by Langenberg. On tuning from one station to another in daylight, when the distant station is at its weakest, the ear can detect no apparent change in volume.

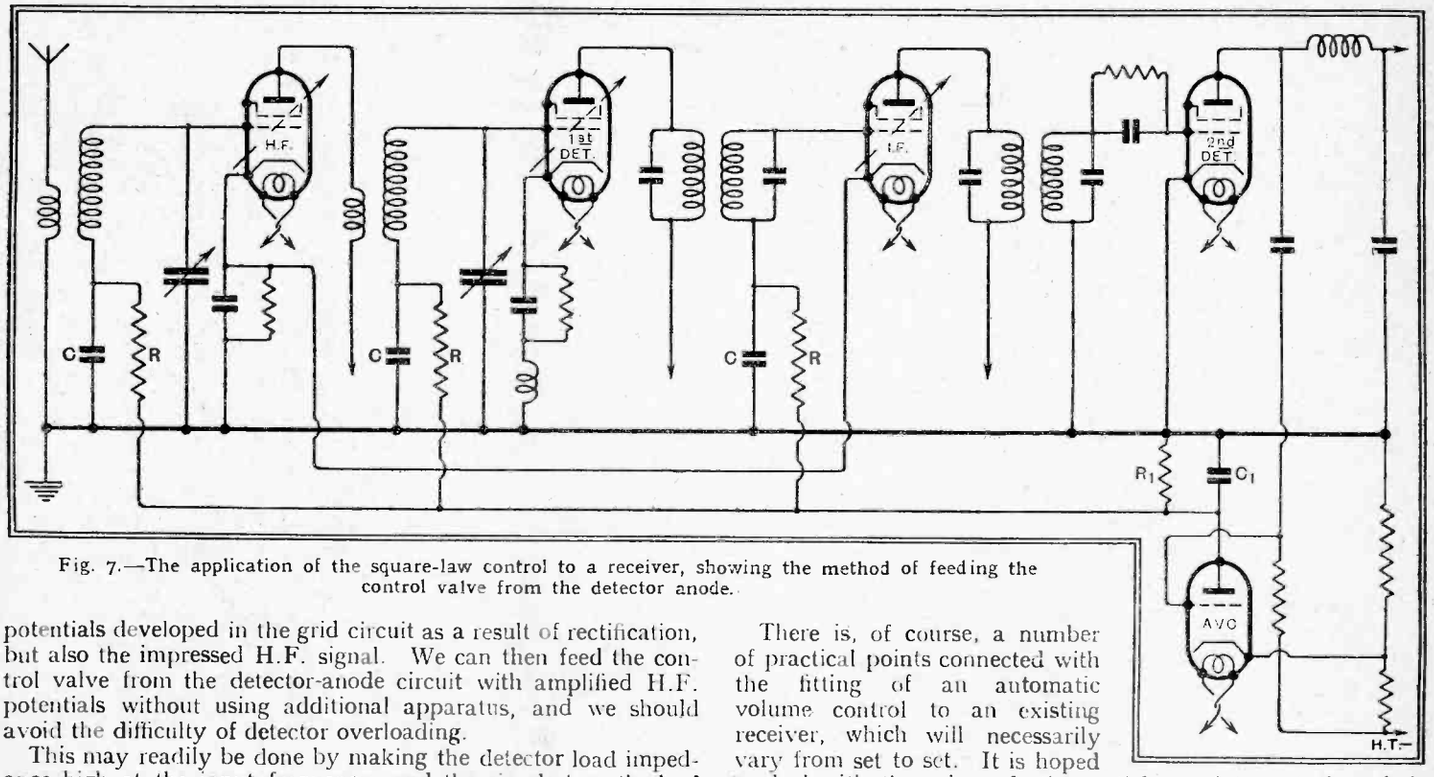


Fig. 7.—The application of the square-law control to a receiver, showing the method of feeding the control valve from the detector anode.

There is, of course, a number of practical points connected with the fitting of an automatic volume control to an existing receiver, which will necessarily vary from set to set. It is hoped to deal with these in a further article, and to put the whole matter on a practical basis by describing the modifications necessary to incorporate an automatic volume control in the Monodial A.C. Super receiver.

NEW BOOKS

ATMOSPHERIC ELECTRICITY, by B. F. J. Schonland, O.B.E., M.A., Ph.D. Pp. 100 + viii, with twenty-five diagrams. Published by Methuen & Co., London. Price 2s. 6d.

The literature—at least the English literature—of "Atmospheric Electricity" is in a singularly uncollected form, and the book under notice is to be commended as giving a very comprehensive review of the subject in a single volume. It is one of the latest additions to Messrs. Methuen's series of monographs on physical subjects.

It is perhaps a criticism of the work that—from a wireless point of view—it deals to only a very small extent with the ionisation of the upper atmosphere (i.e., the Kennelly, Heaviside and Appleton layer) that is of such importance in radio communication. While this is brought under review in its relation to the general subject of atmospheric ionisation at all levels, wireless readers might be inclined to imagine that the subject was worthy of more extensive treatment. Apart from this criticism the amount of information contained in the book is remarkable for a volume of its size.

Starting with ionisation of the atmosphere, the author traces the various factors that contribute to this condition, including that described as "the penetrating ionisation." This agency is considered of sufficient importance to receive the next section to itself, with a review of the methods which have been used to measure it, and an account of the nature and origin of the radiation. The third section deals with electric fields and electric currents in the atmosphere, particularly with the potential gradient in the neighbourhood of the earth's surface, closing with a discussion of the mechanism by which the earth's charge is maintained. The last section of the book is devoted to discussion of thunderstorms and gives an account of the fields and field-charges due to thunderstorms, the electrical qualities involved, the formation of thunder-clouds and the mechanism of the discharge.

J. F. H.

Radio Engineering, by F. E. Terman, Sc.D.—A comprehensive treatment of the more important radio phenomena, including the Propagation of Waves, Circuit Constants, Resonant Circuits, Valves, Modulation, Transmission, Reception, Direction Finding, Measurements, Microphones, Loud speakers, etc. Pp. 688+xi, with 417 diagrams and illustrations. Published by McGraw-Hill Publishing Co., Ltd., London. Price 30s.

Störschutz am Rundfunk-Empfänger in der Praxis, by Heinrich Ike. 2nd Edition. Various methods of eliminating and avoiding electrical interference. Pp. 48, with 40 diagrams. Published by Rothgiesser und Diesing, A.G., Berlin, price R.M.1.

Short Wave Wireless Communication, by A. W. Ladner, A.M.Inst.C.E., and C. R. Stoner, B.Sc., A.M.I.E.E.—Including a brief summary of the theory of Electromagnetic Waves and the Propagation of Short Waves, Problems of Reception, Commercial Receivers and Transmitters, etc. Pp. 348+xii, with 201 diagrams, frontispiece and twelve plates. Published by Chapman & Hall, Ltd., London. Price 15s.

Radio Research Board (of Australia): Reports No. 2, 3, and 4.—*Report No. 2:* Investigations on the state of Polarisation of Sky waves and height measurements of the Heaviside layer in the early morning, by A. L. Green. Pp. 80, with many diagrams. *Report No. 3:* The influence of the earth's magnetic field on the Polarisation of Sky waves, by W. G. Baker and A. L. Green. Pp. 32, with 5 diagrams and addendum. *Report No. 4:* A preliminary investigation of fading in New South Wales, by A. L. Green and W. G. Baker; Studies of Fading in Victoria, on medium waves at short distances, by R. O. Cherry and D. F. Martyn; Observations on Distant Stations in which no ground wave is received, by R. O. Cherry. Pp. 59, with many diagrams. Issued by the Council for Scientific and Industrial Research, Melbourne, Australia.

The Valve Filament

Part I.—The Services which it Renders

By R. T. BEATTY, M.A., B.E., D.Sc.

FOR the expert as well as the novice it is sometimes refreshing and profitable to turn from the complicated details of construction to the simple things which lie at the basis of wireless communication.

A receiving set in a shop window is like an engine with the boiler dry and cold. Switch on the low tension battery and the heated filament emits a copious cloud of slow-moving and, for the moment, useless electrons—a process which is equivalent to filling the boiler with hot water. Switch on the high tension battery and the electrons acquire energy as they are dragged from filament to plate, as steam acquires energy when the oil burners are lit beneath the boiler. And as the slide-valves control the energy of the high-pressure steam, so do the valve grids compel the electrons to flow suitably round the attached coils and condensers.

FAITHFUL and silent service rarely looms large in the public eye. In this article an account is given of the activities which are invisibly at work within and around the filament of a valve. These activities, which a labours of hundreds of research workers have controlled and developed, cause the modern filament to continue for thousands of hours to emit a stream of electrons with the degree of smoothness and steadiness required for first-class reproduction of speech and music.

We are accustomed to think of the electrons as emerging from the filament by a process similar to the evaporation of vapour from a wet surface, but in order to obtain a clearer picture of what is taking place we must examine the conditions inside the metal itself. It will presently appear that the stream of escaping electrons forms but a tiny fraction of a vast population of electrons imprisoned within the metal by a barrier which can only be surmounted by electrons which happen to be endowed with abnormally high velocities.

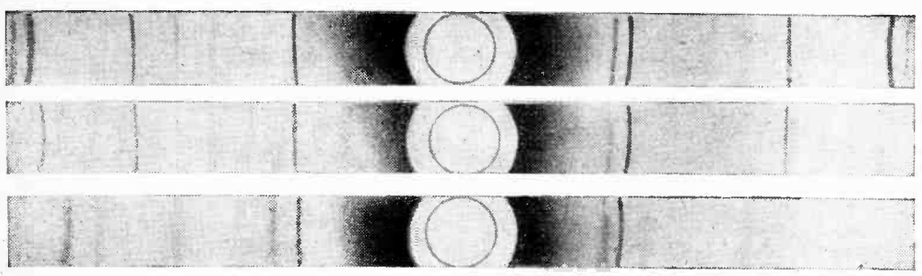


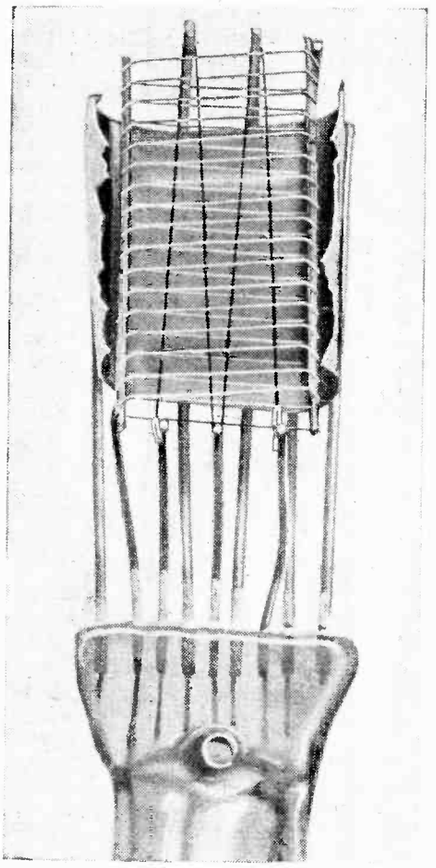
Fig. 1.—X-ray spectra of iron at different temperatures. Though the spectra change in heated iron, owing to recrystallization, the lines are still sharp at a bright red heat (1,100° C.)

We must regard a piece of metal as a lattice work composed of atoms arranged more or less in regular order and packed so closely that though they jostle each other in continual vibration they do not drift from their anchorages. There is none of the tumultuous motion displayed by the scurrying molecules of a gas. This stability of solid matter can be demonstrated in the case of metallic crystals, such as those produced when a tungsten wire is drawn at a red heat through dies. By slow cooling of the drawn wire a single flexible crystal of several feet in length can be produced.

Even the most powerful microscope is unable to reveal the details of the crystal structure, for waves of light are much too coarse-grained to be affected by single atoms, just as a sea-wave reflected from a breakwater bears no trace of the roughness of the stonework though similar irregularities would cause tiny ripples in a pond. But if a piece of the crystalline wire is held in the path of a beam of X-rays, in which the wave-length is comparable with the diameter of an atom, a regular shadow pattern can be obtained on a photographic plate, and from this pattern the crystal structure can be worked out. When the wire is heated the pattern grows indistinct, showing that the crystal is strained owing to the more violent vibration of the atoms, but does not disappear completely even at a red heat.

Sixty Miles per Second

Actually, a metal wire does not consist as a rule of a single crystal; usually innumerable small crystals are present cemented together by uncrystallised metal. But in any case the architecture is stable, and it is not until the melting point is reached that atomic vibrations become sufficiently violent to overcome the cohesive forces and to allow the atoms to wander about in the way which is characteristic of a liquid.



Within the hollow spaces of the lattice work of atoms which composes a metal there moves a swarm of negatively charged electrons, flitting to and fro in a state of comparative freedom. When the terminals of a battery are connected by a wire it is these electrons which alone carry the current: if it were carried by the atoms the wire itself would in the course of a few minutes actually flow into the negative terminal of the battery and be replaced by metal from the positive terminal.

The electrons maintain their energy of motion by collision with the vibrating atoms and, as is the case with any system of colliding bodies, they acquire on the average the same energy of motion (kinetic energy) as the atoms themselves. But since their masses are so much smaller they attain very high speeds—nearly 60 miles per second at ordinary temperatures. The electrons may be thought of as an electrified gas moving freely in the pores of the metal, and when electric force is applied they drift through the metal like smoke through a cigarette.

In any metallic atom there are a few outlying electrons which give the metal its chemical properties. In a gas or vapour (mercury vapour, for example)

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fliers" a given a chance at the microphone.

The existing celebrities are not the only fish in the sea.

quarters.

The opening night will be a notable occasion, for the instrument is the first of its

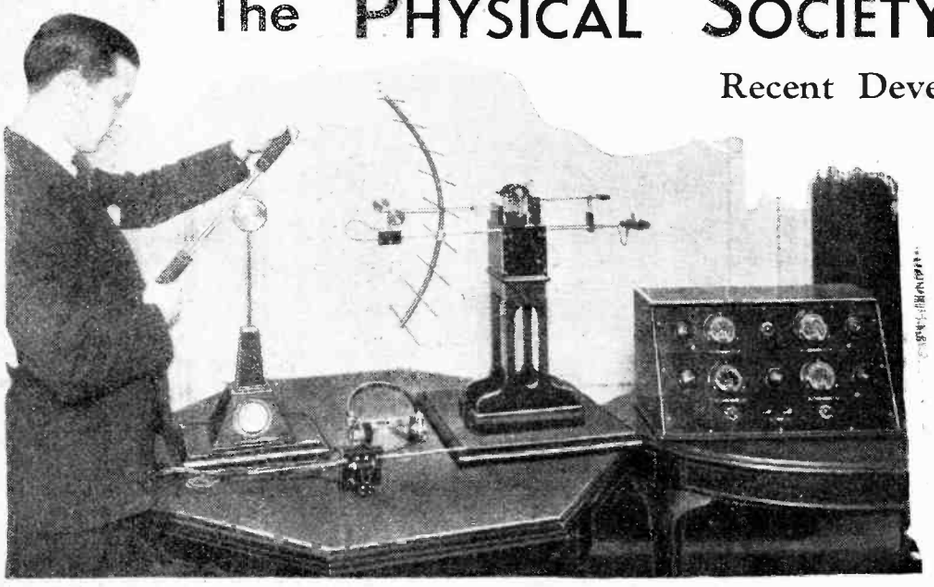
book-publishing, greyhound-racing, education, chiropody, and, ultimately, of Government itself, belongs to another chapter."

he Valve Filament.—

LABORATORY TESTS

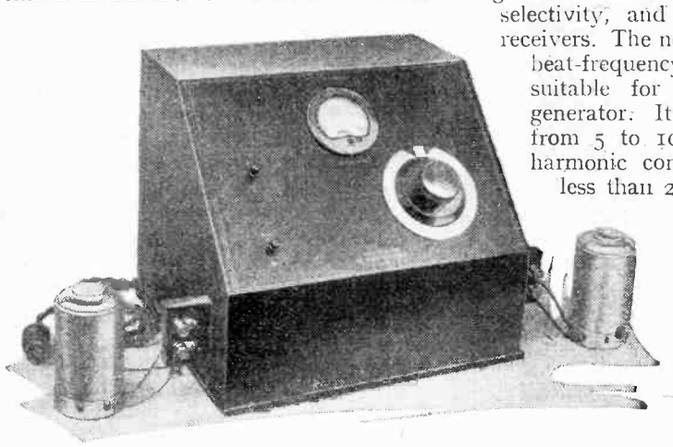
The PHYSICAL SOCIETY'S EXHIBITION

Recent Developments in the Design of Wireless Measuring Instruments



Marconi transmitting and receiving apparatus for demonstrating the properties of ultra-short waves.

THE twenty-third annual exhibition of the Physical Society, held at the Imperial College of Science and Technology on January 3rd, 4th, and 5th, again provided a wealth of material of first importance to those interested in the scientific and engineering aspects of wireless communication. In addition to a number of demonstrations illustrating recent developments in all the important research laboratories, the products of the leading makers of measuring instruments were on view.

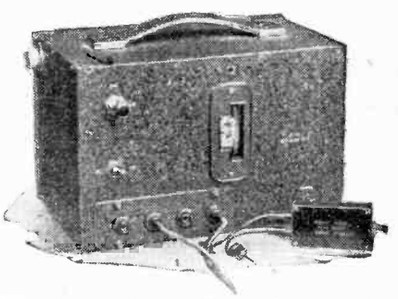


Mains-operated Sullivan inductance matching set for comparing screened or open coils.

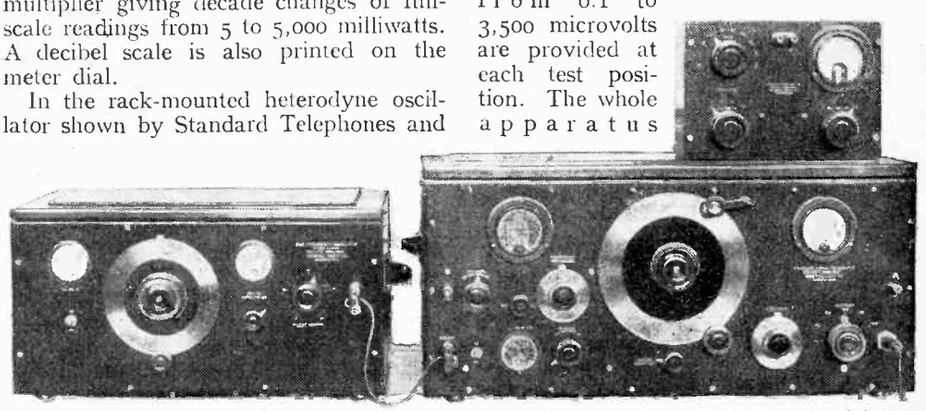
Low-frequency oscillators and signal generators were especially well represented, and the new "G.R." equipment exhibited by Claude Lyons, Ltd., included many outstanding examples of instruments suitable for research and development. The latest model 603-A standard signal generator is an exceptionally versatile instrument. It is battery-operated and completely screened, and has a frequency range from 12 to 3,000 metres. Internal modulation up to 90 per cent. is provided at 400 cycles. The output voltage is adjustable from 0.5 microvolt to 1 volt, and the fact that all the controls are directly calibrated greatly reduces the time required to carry through a calibration. Provision is made for the connection of an external beat-frequency oscillator, so that the instrument is capable of carrying out all the usual tests of sensitivity, selectivity, and fidelity on broadcast receivers. The new "G.R." type 613-A beat-frequency oscillator is specially suitable for use with the signal generator. It has a frequency range from 5 to 10,000 cycles, and the harmonic content of the output is less than 2 per cent. The equipment for set testing is completed by the new type 583-A output power meter. The input impedance range may be varied from 20 to 20,000 ohms, while the output meter, which is of the rectifier type, is provided with a multiplier giving decade changes of full-scale readings from 5 to 5,000 milliwatts. A decibel scale is also printed on the meter dial.

In the rack-mounted heterodyne oscillator shown by Standard Telephones and Cables, Ltd., an ingenious device is incorporated for checking the accuracy of the frequency scale. The output is switched on to a small moving-iron unit to which are attached two vibrating reeds tuned to resonate exactly at 50 and 500 cycles. The main dial is rotated until the amplitude of vibration of one of the reeds, as viewed through a small inspection door, reaches a maximum. The zero adjustment of the oscillator is then set to bring the main scale to the reading corresponding with the frequency of the reed in resonance. A similar device is incorporated in the Muirhead N.P.L. beat-tone oscillator.

The requirements of works test departments are somewhat different from those of the research and development sections, and Messrs. E. K. Cole, Ltd., were exhibiting a master signal generator capable of supplying as many as twelve test benches with a modulated source suitable for checking receivers in production. Five frequencies are provided, three on medium and two on long waves, and a separate oscillator panel incorporating its own L.F. oscillator and modulator is used for each frequency. A dummy aerial and an attenuator giving a variable output from 0.1 to 3,500 microvolts are provided at each test position. The whole apparatus



"Ekco" service oscillator incorporating three-step attenuator and dummy aerial.



A group of the latest "G.R." instruments shown by Claude Lyons, Ltd. (Left) Type 613-A beat frequency oscillator; (Right) Model 603-A standard signal generator and Type 583-A output power meter.

The Physical Society's Exhibition—

is exceptionally strongly made and is well adapted to factory conditions. The same firm is also showing a compact test oscillator designed for use by service agents in fault-finding and checking the

Weston model 662 test oscillator with a modulated output covering the medium-wave, long-wave and I.F. ranges.

alignment of receivers under working conditions. A dummy aerial forms part of the equipment, and in addition to the usual medium- and long-wave H.F. ranges an I.F. range is provided, so that all circuits in a superheterodyne receiver may be checked for correct alignment.

The Weston model 662 test oscillator is another example of an instrument designed for the service man, and provides a modulated source of I.F., long-wave, and medium-wave power for routine testing.

Dynatron Oscillators

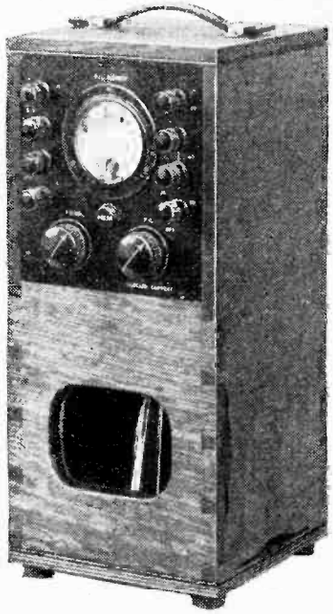
The dynatron oscillator seems to have come into its own this year and is being used, on account of its high degree of frequency stability, not only in heterodyne wavemeters, but also in beat-frequency L.F. oscillators. The new inexpensive universal wavemeter shown by Messrs. H. W. Sullivan, Ltd., is a good example of the application of the dynatron and has a frequency stability of the order of 0.001 per cent. By the addition of a valve voltmeter unit specially designed for the purpose, this wavemeter can be rapidly converted from the heterodyne to the absorption type. Incidentally, the coils used are a new form of the well-known Sullivan-Griffiths thermal-compensated type.

In modern receiver manufacture the correct matching of inductances and ganging of tuning condensers is of the first importance. The inductance matching set shown by Messrs. H. W. Sullivan, Ltd., and the gang condenser bridge made by E. K. Cole, Ltd., are examples of the type of instrument which is now available to the radio manufacturer.

But the interest of the Exhibition from the wireless point of view was not centred exclusively in measuring apparatus. There were a number of experiments and demonstrations on subjects closely allied to broadcasting. The Dubilier Condenser Co., for instance, were showing the effect of their sparking-plug interference suppressors on the character of the spark discharge. This was viewed through an oscilloscope, and the effective radiation with and without suppressor was demonstrated simultaneously with a three-valve receiver of standard design.

On the Standard Telephones exhibit a demonstration was given of high-grade telephony, the instruments used being the latest moving-coil microphone and headphones in conjunction with one of their portable O.B. amplifiers. A comparison was made with a high-grade carbon microphone, and the improvement over the latter type, particularly in the reproduction of sibilants, was most marked.

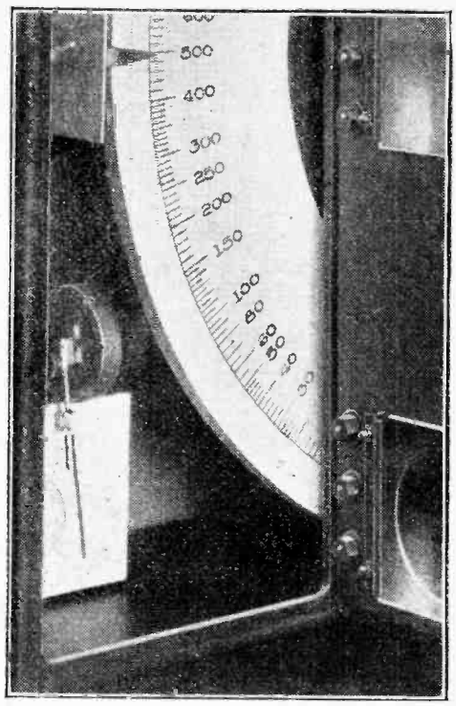
The Marconi Co. gave a demonstration of the properties of ultra-short waves with apparatus specially designed for schools and colleges. The wavelength used was 50 cm., and exploration of the space surrounding the transmitter with a doublet receiver demonstrated the properties of focusing and polarisation associated with



Standard Telephones portable cathode ray unit. The image is viewed downwards through the wall of the tube.

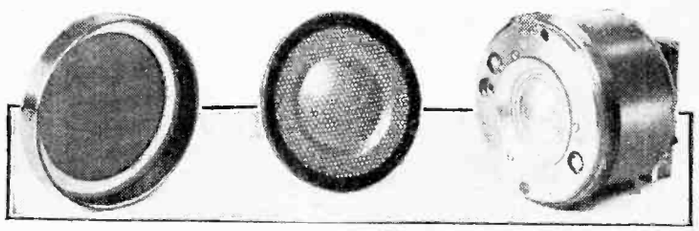
these short wavelengths. There was also a demonstration of the application of ultra-high-frequency currents for medical and surgical diathermy treatment. Another interesting exhibit from the design point of view was a television amplifier with a flat response characteristic from 10 to 150,000 cycles.

On the Westinghouse stand the advantages of the new "Westector" copper-oxide rectifier in A.C. instruments at high frequencies were demonstrated. Experiments were also arranged to illustrate the properties of cupreous oxide photo-electric cells, and demonstrations were given of the method of sputtering a gold film on the surface of the oxide to obtain good electrical contact without appreciable light absorption.



Vibrating reed frequency check in the Standard Telephones heterodyne oscillator.

One of the most interesting stands in the Research and Experimental Section was that arranged by the Post Office Engineering Research Station (Dollis Hill). The use of a sound film for replacing the familiar signalling tones in the automatic telephone exchanges by spoken words is a probable future development. The sound film, which gives such phrases as "Number engaged" or "Number unobtainable," is mounted vertically on the edge of a revolving drum through which light is passed on to a photo cell. The appropriate phrase is selected by switches controlled automatically from the exchange. Another outstanding exhibit on this stand was the precision heterodyne oscillator designed by Dr. Ryall. Dynatron oscillators are employed to give frequency stability and an ingenious correction circuit employing a shunted metal-oxide rectifier is incorporated in the amplified section to compensate for curvature of the valve characteristics. Between 20 and 12,000 cycles the output does not vary more than 0.1 decibel, and the harmonic content above 50 cycles is less than 1 per cent.



Moving-coil microphone used in the demonstration of high-quality speech reproduction by Standard Telephones and Cables, Ltd.

In conclusion, special mention should be made of the beautifully finished valve-maintained tuning fork panel made by Muirhead and Co., Ltd., for the British Broadcasting Corporation.

M.R.G. Console 3 Radio-gramophone

Satisfactory All-round Performance and Outstanding Quality

WITH regard to the desirable qualities of a radio-gramophone. there are two schools of thought. It is often held that, on the radio side, reproduction of more than two or three programmes is unnecessary or even undesirable, and that the inevitable complications brought about by providing long range and high selectivity are quite out of place.

Those who hold the opposite opinion contend that, as a radio-gramophone is bound in any case to be bulkier and rather more costly than a plain radio set, a fairly ambitious receiver chassis might just as well be included, in order that the outfit may be placed in the "de luxe" class. Both sides make out a good case for their contentions, but they are in complete agreement with regard to the need for striving after the best attainable quality combined with realistic volume.

In the M.R.G. Console 3, what would appear to be a happy compromise has been struck; although the radio equipment is not of the most ambitious type, it is very much more than a local-station set, and should satisfy all reasonable needs. With regard to the all-important quality of reproduction, an exceptionally high standard has been achieved.

Although the circuit arrangement is basically the popular H.F.-det.-L.F. three-valve combination, there are several unusual features, which should perhaps more fairly be described as refinements. Input and output circuits of the H.F. stage are of the single-tuned variety; the tuned-anode system of intervalve coupling is employed, but, very wisely, the anode connection has been "tapped down" on both medium and long waves, in spite of the fact that this procedure necessitates an extra switching point. The H.F. valve is of the variable-mu type, and so its sensitivity is naturally controlled by variation of grid bias.

Separate reaction windings are provided for each waveband, and waverange switching is arranged throughout so that the contacts are in series and not in parallel with any coil. When the detector valve is converted into an amplifier for gramophone reproduction its grid circuit is entirely disconnected from the tuning system by means of a three-point switch.

After the detector valve comes an output pentode, which is coupled by means of a resistance-fed transformer; decoupling is employed in both anode and grid circuits.

Rectified anode current, derived from a full-wave valve, is smoothed by the series-connected loud speaker field in conjunction with a pair of high-capacity dry electrolytic condensers.

A constructional point of special interest is the horizontal indicator scale, which is marked both in wavelengths and the settings corresponding to principal stations on both bands. The scale is actually of glass, and the tuning indicator is a narrow bar of light directed on the scale through a slotted metal cursor carried on a rubber-tensioned silk band suitably guided over pulleys.

FEATURES

General.—*A three-valve self-contained radio-gramophone with built-in moving-coil loud speaker of the energised type. For operation on A.C. mains with an external aerial.*

Circuit.—*One H.F. stage, with single-tuned input and intervalve circuits. Capacity-controlled reaction and H.F. volume control by grid bias adjustment. Power grid detector, coupled by parallel-fed transformer to output pentode. Full-wave rectifier; smoothing by loud speaker field coil.*

Controls.—*(1) Single tuning control. (2) Combination on-off, radio-gramophone change-over and wave-range switch. (3) Reaction. (4) Combined radio and gramophone volume control.*

Price.—*23 guineas, complete.*

Makers.—*Mains Radio Gramophones Ltd., Vaughan Street, Bradford, Yorks.*

The tuning coils, enclosed in cylindrical shields, are considerably larger—and, therefore, one may conclude, more efficient—than usual. They are mounted on a common axis, and in the operation of wave-changing are rotated bodily through a few degrees by a mechanical link controlled by the switch in order to transfer connections to the appropriate points for each waveband. This unconventional wave-changing system should offer the advantage of less exposed H.F. wiring, and, consequently, should make it possible to obtain greater H.F. amplification without running into instability.

In order that the constants of the input circuit may be adjusted to suit aerials of varying capacity, a get-at-able aerial series condenser is mounted at the back of the set.

Instead of soldering the various connections between the receiver chassis proper and the loud speaker, gramophone motor, and pick-up, plug-and-socket connections have been fitted for all these leads, with the result that the chassis may be removed from the container for examination or repair in a few moments without special tools or skill. This is a good point, and it has enabled the manufacturers to arrange a "service" scheme that is particularly attractive to owners.

Accessories associated with gramophone reproduction are of good quality and sensibly arranged; the electric turntable motor is a Garrard, fitted with automatic-stop mechanism.

Result of Tests

All the apparatus is housed in a large cabinet of quite attractive appearance, which, considering the extremely reasonable price of the set, is very well made. Most important of all, the cabinet is especially satisfactory from the acoustic point of view, giving no trace of undesirable resonance or "boxiness."

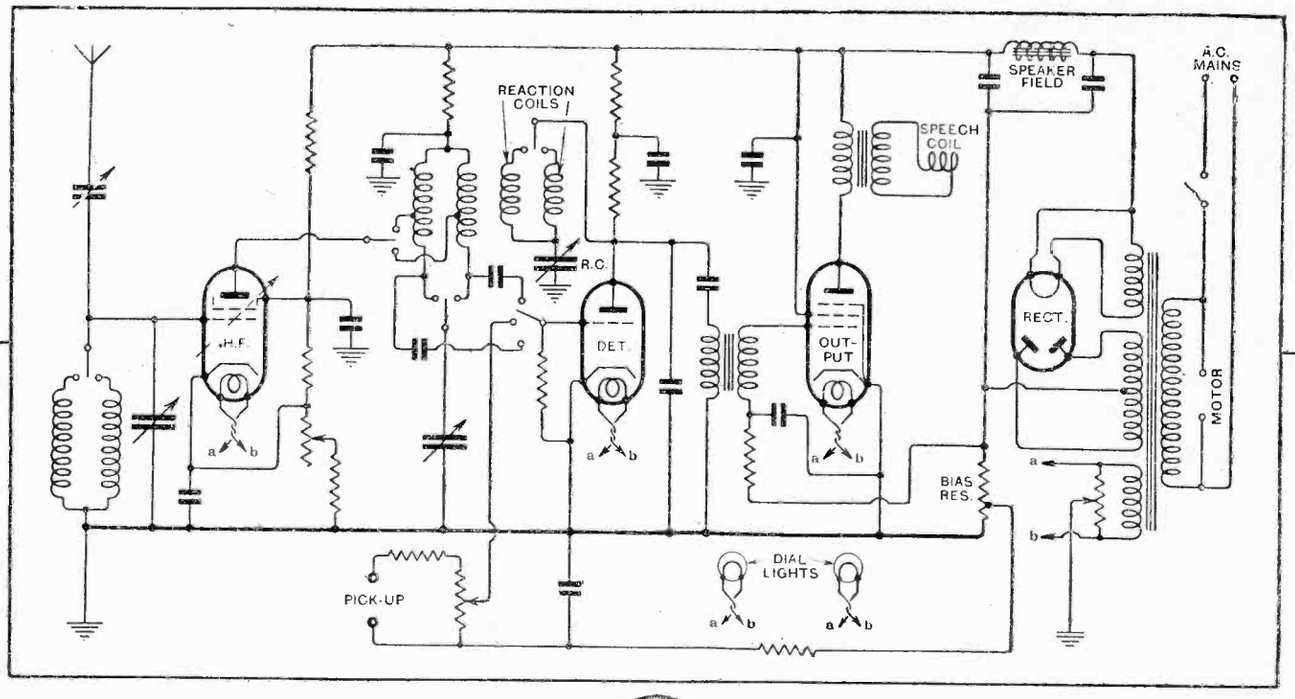
Judged on a combined basis of sensitivity and selectivity—the only fair way—the performance of the set is above the average standard. For this the variable-mu H.F. valve and efficient coils are no doubt largely responsible, as is also the special arrangement of the H.F. intervalve coupling. In spite of the fact that separate windings are provided for each band, reaction did not appear to be outstandingly good, but true sensitivity is sufficient to avoid too much dependence on this control as an aid to receiving the weaker stations.

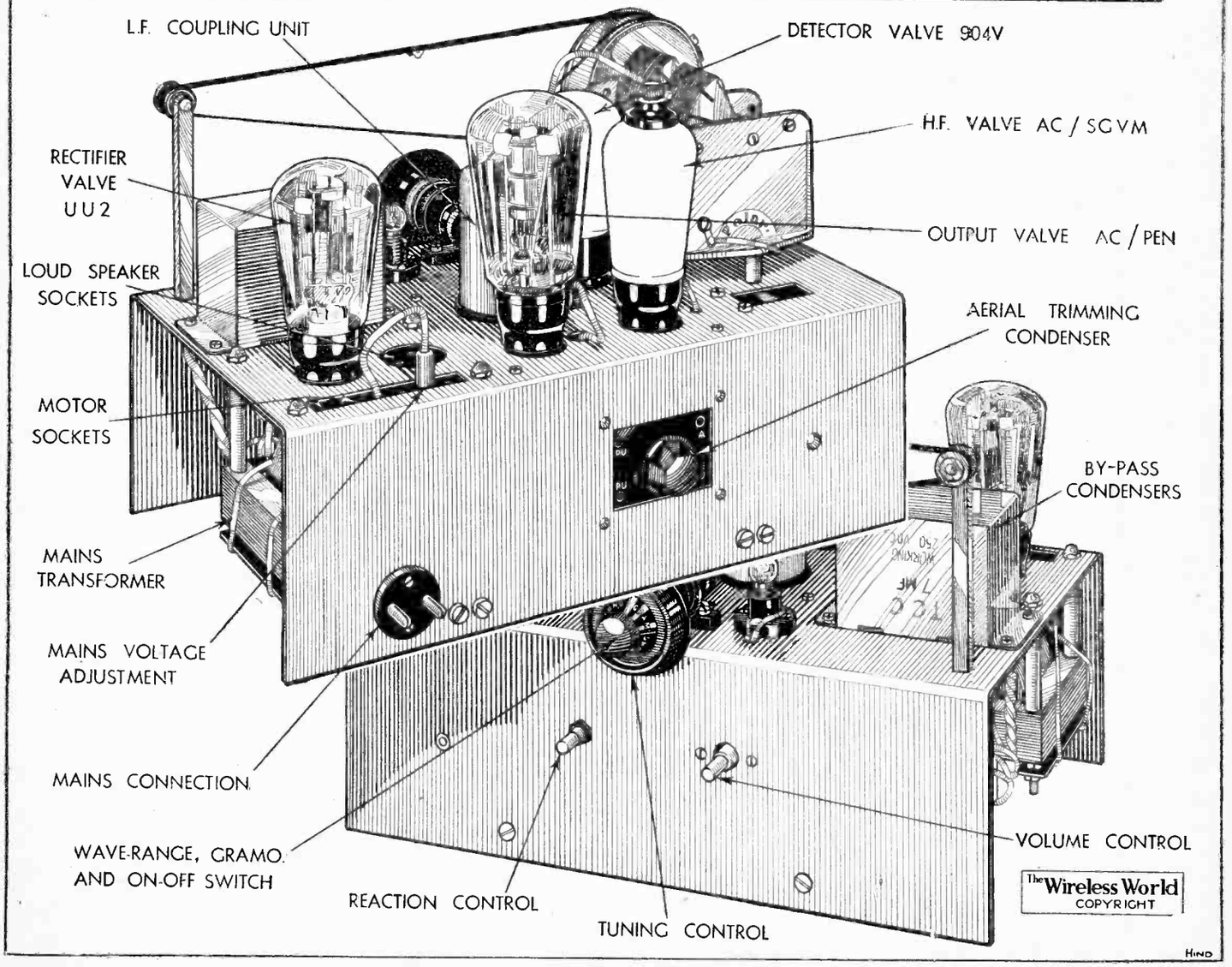
We were particularly impressed by the crispness and clearness of reproduction; there were no signs of roughness or harmonic distortion. Speech is highly intelligible, and, when listening to an orchestral item, it is exceptionally easy to pick out individual instruments.

What bass resonance there is is slight, and occurs at a frequency well over 100 cycles. Those who favour excessively "mellow" reproduction might consider that the output of the M.R.G. set is rather on the "bright" side, but it is certainly a very pleasing instrument to listen to.

There is a similar absence of resonances in the middle and upper registers, output being sensibly constant up to about 4,000 cycles. Volume is satisfactory for ordinary domestic needs.

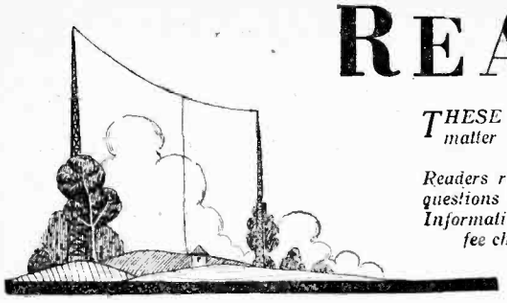
Radio or Records without Complications





Two views of the M.R.G. metal-framed chassis, and (inset) the complete circuit diagram.

READERS' PROBLEMS



THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Adding a "Loose Coupler"

WHEN readers ask for help in improving the selectivity of somewhat out-of-date sets, our first suggestion is that a separately tuned aerial circuit should be added whenever this feature is not already included. Except perhaps in a set with a variable-mu H.F. valve, one can hardly claim even to have begun to tackle the problem of interference until this addition has been made.

Circumstances alter cases, and so it is natural that the same type of "loose coupler" will not of necessity be best for every receiver. But very little risk will be run by adopting the arrangement shown diagrammatically in Fig. 1, and indeed this is the circuit recommended in nine cases out of ten, partly because of its adaptability and the fact that no internal alterations in the receiver are involved.

For the coil assembly almost any "two-range aerial tuner" of reasonably good design will be suitable, but reasonably efficient windings should be chosen. An arrangement with controllable aerial coupling between primary and secondary circuits is desirable but not essential.

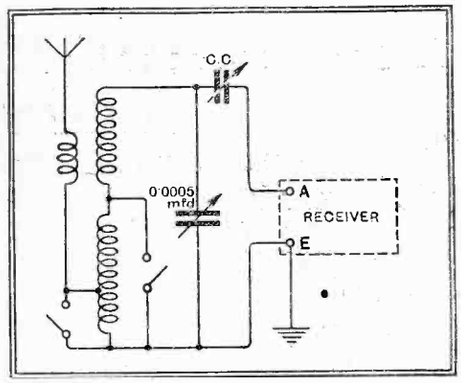


Fig. 1.—One of the simplest and most satisfactory methods of adding a separately tuned aerial circuit to an existing receiver.

Writing on the question of adding a two-circuit aerial tuner to his "kit" set, which is no longer selective enough for present-day conditions, a correspondent asks whether the external aerial coil should be screened. Direct magnetic coupling between the added coil and any coil in the set is bound to be harmful, but as our querist's receiver includes coils which are completely shielded, we think he will be safe in using an unscreened input coil. By doing so, the general efficiency of the set is likely to be rather better than if a small "potted" coil assembly were employed.

With regard to the coupling condenser (CC in the diagram) a maximum capacity of 15 or 20 micro-microfarads is ample when "direct" aerial coupling was fitted in the original set. In other cases, a capacity of 0.0001 mfd. may not be too high.

Double Superheterodyne

ALTHOUGH it is not impossible to employ a superheterodyne short-wave adaptor in conjunction with a set in which the same principle of reception is employed, the procedure is not one that can be generally recommended. Even although screening may be as complete as is normally practicable, it is probable that harmonics of the two oscillators will beat together and produce whistles at many points.

One way out of the difficulty is to connect the short-wave adaptor to the anode circuit of the first detector of the main receiver, and to remove or disconnect the oscillator valve.

Screened Pick-up Leads

WHEN a mains-driven set operates for radio reception with a silent background, hum being only evident on gramophone reproduction, we are always inclined to suspect electrostatic couplings to the pick-up leads, etc. If the hum be high-pitched, it is almost certain to be due to interference of this nature.

To overcome the difficulty, it is usually recommended that the pick-up connections should be run in earthed screened wire.

To a reader who has tried this plan with only partial success we recommend that he should also try the effect of screening in a similar way the leads connected to his radio-gramophone change-over switch.

Balancing Push-pull Valves

IN view of the revival of interest in push-pull amplification, more especially as applied to battery sets, a query on this subject comes at a very opportune moment.

It is quite common practice to precede a push-pull stage by a split-secondary transformer, in which separate windings are provided, so that the anode current of each output valve may be balanced by an individual adjustment of grid bias. Without a special component of this type it is usually considered that each valve must of necessity be operated at the same bias.

A reader who has a plain "unsplit" transformer asks whether it would not be possible to strike a balance by "backing off" the negative bias of the particular valve which happens to consume the lower anode current by means of one or two dry cells connected directly to its grid.

This plan runs contrary to usually accepted procedure, but is certainly quite practicable, although it is always considered that the grid of an amplifying valve should be kept clear of long wires or, in this case, of a mass of metal, which amounts to virtually the same thing. But, by using very small flashlamp cells, which may be suspended in the wiring, risk of trouble on this score is quite negligible, and so the scheme is well worth while trying. Connections will be as in Fig. 2 (a).

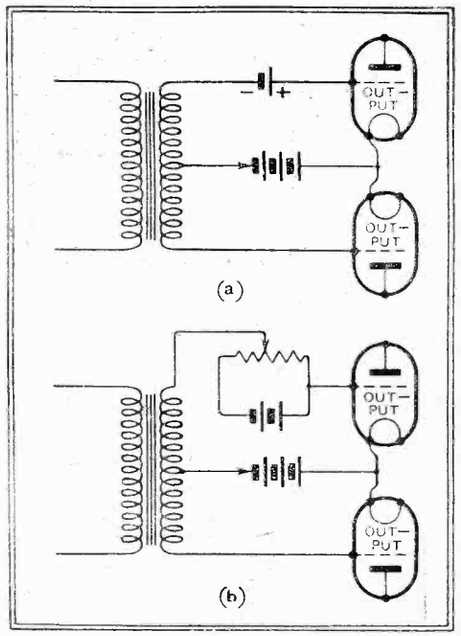


Fig. 2.—Provision for individual adjustment of grid bias in a push-pull output stage. Finer control is obtained by fitting a potentiometer, as in diagram (b).

Where fine adjustment of the "backing-off" voltage is required, a potentiometer, in conjunction with dry cells, may be used. These additions should be carefully mounted in close proximity to the grid terminal, an insulating bracket being fitted as a support for the potentiometer.

Self Adjusting

A READER who has added an H.F. stage to an existing A.C. receiver sends us a circuit diagram showing modifications that have been made, and asks for information as to the changes in the values of bias resistors throughout the set.

Due to the extra demands of the added H.F. valve, anode voltages of all the original valves are bound to be slightly reduced. But it may be taken as an almost invariable rule that this does not imply the need for alteration of bias resistance values. Current flowing through the resistors will be less, and so the bias voltages built up across them will be proportionally reduced. It is fortunate that circuits of this type are almost perfectly self-regulating, and are capable of adjusting themselves automatically to suit quite considerable changes in H.T. voltage.

The Wireless World INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

The Wireless World

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CONTENTS

EDITORIAL COMMENT

Quiescent Push-pull

Important Advantages

IN this issue we include the first design published in this country for building a receiver incorporating the new method of employing push-pull transformer coupling, which, because of its special properties, has come to be known as "Quiescent Push-pull."

The general principle of push-pull is, of course, old and it is necessary to be quite clear in the distinction between push-pull as we have been accustomed to understand it and the special effects obtainable under the new arrangement. In theory, the idea of quiescent push-pull has been with us for some time, and, to give only one example, we may refer to an article by Dr. N. W. McLachlan, in *The Wireless World* as far back as May, 1929, in which considerable light from a theoretical point of view was shed on the subject.

In the ordinary push-pull arrangement, where grid bias is applied in the orthodox manner at the mid-point of the valve characteristic, one valve pulls and the other pushes to an even amount, and there is a constant drain on anode current so long as the set is switched on, whether the signal is coming through or not.

In the case of quiescent push-pull the arrangement is altered so that the bias is at the bottom of the valve characteristic, and whilst one valve is pushing the other valve is inoperative or quiescent, the effect being that anode current remains at a very small value and only rises with a signal, and the average battery current over a period of listening is little more than the quiescent current.

The reason why we attach importance to this development in battery circuits is, first, on account of marked economy in H.T. consumption, and, secondly, the very great increase in volume and improvement in quality which it is now possible to obtain from a battery set under economic conditions. The use of moving-coil speakers in conjunction with battery sets has hitherto been unusual, except where the user could afford to disregard the question of battery costs, or was prepared to use accumulator high tension batteries.

Two other points of importance should not be missed; first, that this development makes the truly portable set a much more attractive proposition now that it can be designed with a moving-coil speaker, and, secondly, gramophone reproduction with a quiescent push-pull output circuit becomes worth while.

Interference Crusade

Progress Towards Legislation

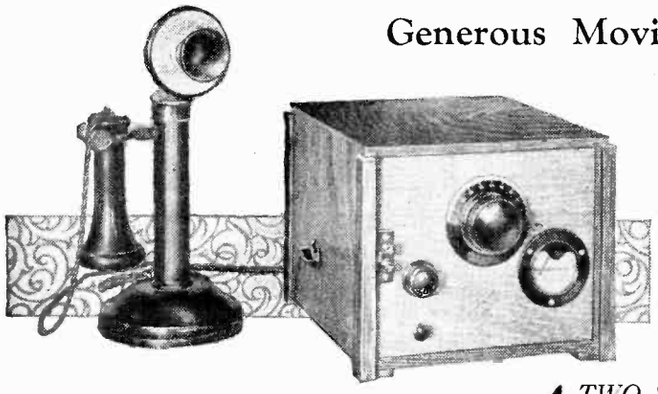
SUBSTANTIAL progress is being made towards the goal of legislation on the subject of electrical interference with wireless reception. Discussions which we have had with individuals and organisations whose support would be essential indicate that strong support will be forthcoming at the appropriate moment.

We would urge the importance of a discussion on various aspects of the problem and would welcome letters for publication in our Correspondence.

The proposal as it stands at present is that the first aim would be to prohibit or restrict the sale of any electrical apparatus capable of radiating so as to interfere with wireless reception; secondly, to prohibit the installation of such apparatus; and, thirdly, to legislate for reasonable but not oppressive action to suppress existing interference over which there is at the present moment no legal control.

THE QUIESCENT PUSH-PULL TWO

Generous Moving-coil Speaker Output from Small Battery Set



By
W. I. G. PAGE,
B.Sc.

A TWO-STAGE battery receiver for local station reception embodying two pentodes in quiescent push-pull. Although the total H.T. consumption of the receiver is only 8mA. under working conditions, the power output reaches the remarkable level of nearly 1½ watts A.C. Thus it is possible with an H.T. battery of the smallest capacity to enjoy an output volume from both radio and gramophone which vies with that obtainable from a mains receiver.

FEW battery set users would deny that, in the chain of operations between aerial and loud speaker, the "missing link" has hitherto been that extra amount of power or "punch" necessary for life-like reproduction. However skilful the design and construction of the battery set of reasonable H.T. consumption, and however pure its output may be, there has always been this difference between it and even the less ambitious form of mains-operated receivers.

The new era ushered in by "Quiescent Push-Pull"[1] will probably have a profound effect on our attitude towards battery sets and may give a new lease of life to a type of receiver which for some time past has unquestionably been neglected. It is interesting to note that there are already Quiescent Push-Pull commercial receivers appearing on the market—the first being the Pye G/B; this can be considered as a further endorsement of the efficiency of the arrangement.

Small Battery Consumption

"The Quiescent Push-Pull Two," constructional details of which form the subject of this article, has been designed to demonstrate this new development and amply justifies the brief description—"Multum in Parvo"—given to the receiver in last week's issue. The remarkable loud speaker output of nearly 1½ watts A.C.—volume enough for the largest of rooms—is obtained with a total average H.T. consumption of only 8 mA., which is within the capabilities of the smallest-capacity H.T. battery. The size of the receiver can best be gleaned from the title illustration above, where an ordinary desk telephone is shown alongside.

In addition to improved radio reception, one of the most important advantages conferred by quiescent push-pull (Q.P.P.) is in respect of gramophone reproduction. Hitherto, with the ordinary type of battery set, the acoustic output has been rather less than that of the gramophone alone—unaided electrically, and could hardly be considered worth while. Now it is possible with a simple and economical two-stage receiver to enjoy an output volume which is equivalent to that from a mains set. Pick-up sockets are included on the panel of the receiver under discussion and gramophone reproduction is extraordinarily effective.

Although Q.P.P. output calls for no special circuit in the H.F. or detector stages and any "straight" or superhet. scheme may precede it, it has been thought advisable to build the first constructional set for local station reception—an arrangement comprising a simple detector transformer-coupled to two Mazda Pen. 220A valves in Q.P.P.

The input consists of a single tuned circuit in which an adjustable aerial rotor gives variable selectivity. Up to some forty miles from twin Regional transmitters the set gives satisfactory and interference-free local reception, but those living in the wipe-out area will perforce have to use a band-pass filter in place of the tuned circuit of Fig. 1, and will find that "The Flexible Band-Pass Unit"[2] will give excellent results.

Transformer Ratio

In order that the detector shall load completely the two output pentodes without the employment of an intermediate L.F. stage with its extra equipment and added H.T. consumption, it is essential that the intervalve transformer should have a ratio of 8 or 9 to 1, otherwise the detector will overload first and the full power output will never be obtained. Special transformers of suitable characteristic are available from Sound Sales, Multitone, R.I., and Varley, and are capable of giving an excellent performance when a primary current of 2 mA. (the anode current of the HL2) is passed. The secondary must be centre-tapped and close to the terminal a non-inductive resistance of 150,000 ohms (R4) must be connected to prevent parasitic oscillation which otherwise can give rise to an unpleasant form of distortion on loud signals. Separate grid stoppers close to the control grid of each pentode are not

[1] See "Outstanding Battery Set Development," *The Wireless World*, January 6th, 1933.

[2] See *The Wireless World*, dated October 14th, 1932.

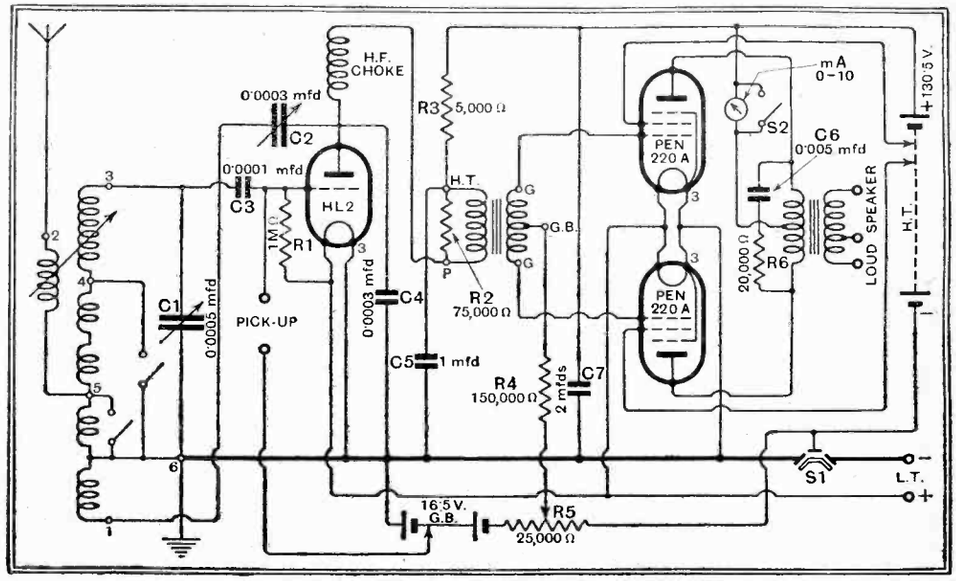


Fig. 1.—The complete circuit diagram. Care should be taken when wiring the valve-holder for the metallised HL2 valve to see that the pin marked 3 is connected to L.T. negative.

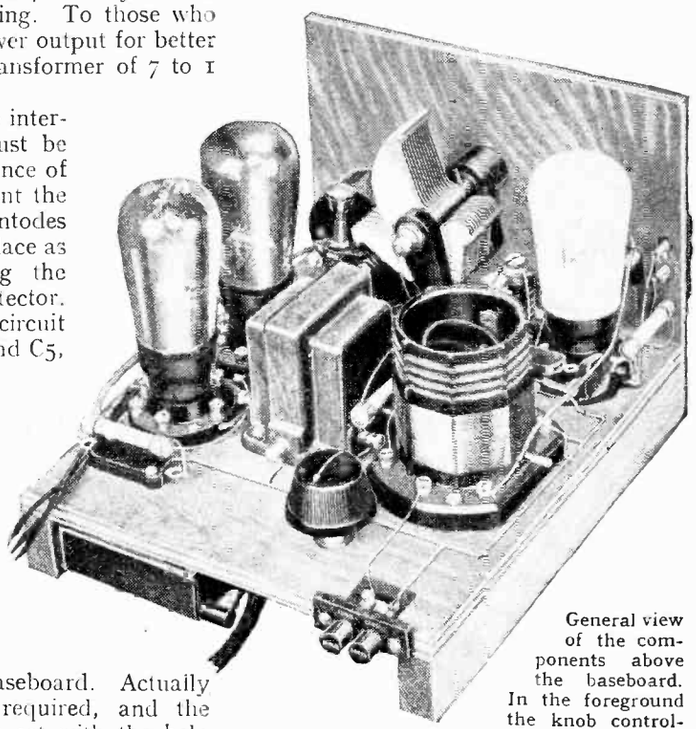
The Quiescent Push-pull Two—

so effective as a single resistance.

A transformer which has not yet been mentioned but which gives signals of exceptionally good quality is the well-known Ferranti AF6C, having the high primary inductance of 70 henrys when 2 mA. D.C. are passing. To those who will sacrifice some power output for better bass response, this transformer of 7 to 1 ratio should appeal.

The primary of the inter-valve transformer must be shunted with a resistance of 75,000 ohms to prevent the demise of the pentodes should a surge take place as a result of breaking the anode circuit of the detector. The detector output circuit is decoupled by R3 and C5, and no L.F. oscillation is likely to occur when the resistance of the H.T. battery rises.

Bias for the output valves is derived from a 16½-volt battery, which is shunted by a 25,000 ohm potentiometer R5 and is housed beneath the baseboard. Actually about 15 volts are required, and the potentiometer slider is set with the help of the milliammeter on the panel, as explained later. When the set is in use the bias battery is discharging through R5 at such a rate that its voltage decreases in about the same proportion as the drop in H.T. volts. The 3-point switch S1 breaks the L.T. and open-circuits the bias battery.



General view of the components above the baseboard. In the foreground the knob controlling the bias potentiometer can be seen.

A specimen receiver is available for inspection at 116-117, Fleet Street, London, E.C.4.

The filament terminals of the two valve holders for the Pen. 220A valves must be wired so that the valve pins marked 3 are connected to L.T. negative, thus ensuring that the suppressor grids (now connected to the end and not to the centre of the filament) are at true earth potential. A special 130-volt Drydex H.T. battery is available for this type of receiver and is arranged with 1½-volt tappings from 120 to 130½ volts, thus providing a means of matching the anode currents by the simple expedient of altering the individual H.T. voltages applied to the two auxiliary grids. The maximum H.T. voltage should be used for the anode circuits.

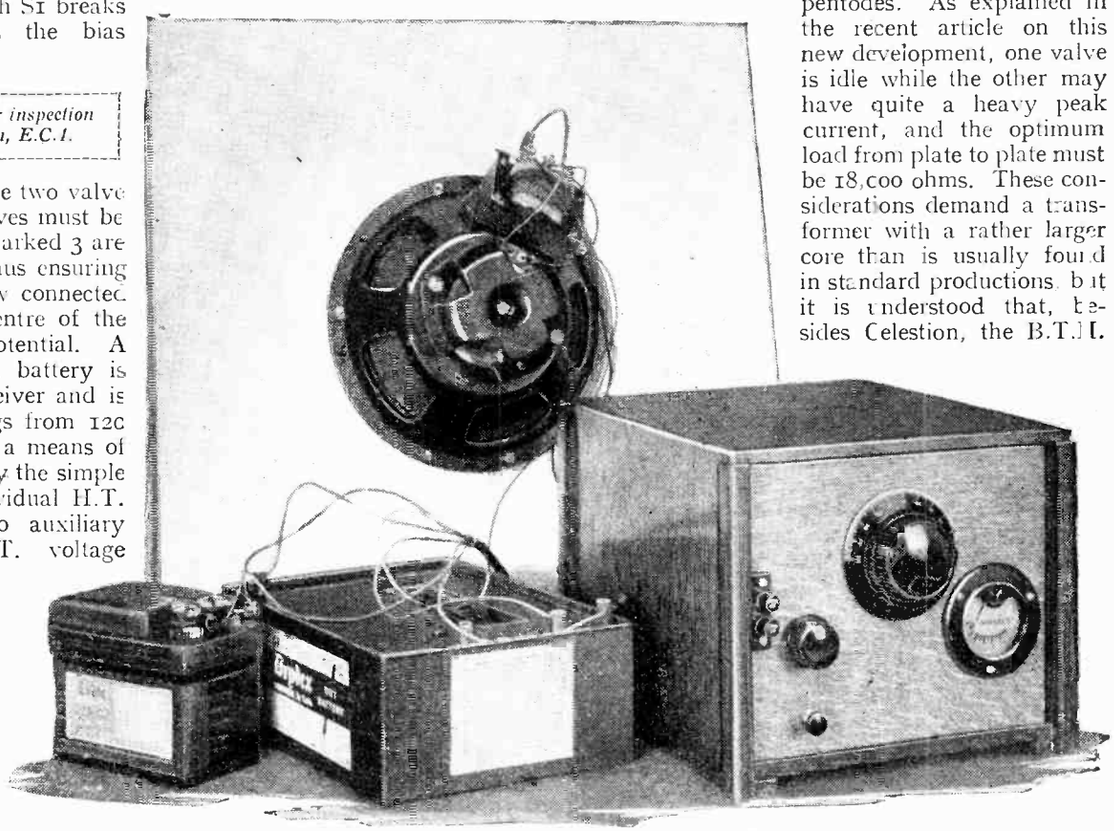
A milliammeter reading from 0 to 10 mA. is arranged on the panel, and is not only used for matching the output valves, but provides a means of setting the total quiescent anode current at 4 mA. when no signal is being received. Its assistance is only called upon during the initial adjustments of the receiver and, say, at intervals of a month. Across the output transformer primary, which is centre-tapped, a compensator circuit C6R6 is joined so as to limit the impedance of the loud speaker at the higher frequencies. The best value for C6 in the case of the special Celestion moving-coil speaker specified is 0.005 mfd., while R6 should be about 20,000 ohms.

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Slow motion variable condenser, 0.0005 mfd., C1 — **Formo No. 100**
1 intervalve L.F. transformer, 9:1 — **Sound Sales SS/PP9** (Multitone, Ferranti, R.I., Varley)
1 Dual range coil, with 200-, 400-, or 600-turn rotor — **Colvern RM2S** (Lissen)
1 Milliammeter, 0-10, moving iron — **Sifam E66**
1 On-off switch, with clips for meter, S2 — **Benjamin Type B**
3 Valve holders, 5-pin — **Junit**
1 Potentiometer, 25,000 ohms, R5 — **Rotorohm**
1 Pair G.B. battery clips — **Gripso**
1 Switch, 3-pt., S1 — **Telsen**
1 H.F. choke — **McMichael Binocular Junior**
1 Reaction condenser, 0.0003 mfd., C2 — **Polar "Compax"**
2 Twin socket strips, aerial, earth, 2 pick-ups — **Belling-Lee**
1 Grid leak, 1 megohm, R1 — **Dubilier**
1 Metallised resistance, 5,000 ohms, 1 watt, R3 — **Dubilier**
1 Metallised resistance, 20,000 ohms, 1 watt, R6 — **Dubilier**
1 Metallised resistance, 75,000 ohms, 1 watt, R2 — **Dubilier**
1 Metallised resistance, 150,000 ohms, 1 watt, R4 — **Dubilier**
1 Fixed condenser, 0.005 mfd., C6 — **Dubilier No. 670**
1 Fixed condenser, 0.0001 mfd., C3 — **Dubilier No. 665**
1 Fixed condenser, 0.0003 mfd., C4 — **Dubilier No. 665**
1 Fixed condenser, 1 mfd., 250 volts, D.C., working, C5 — **Peak**
1 Fixed condenser, 2 mfds., 250 volts, D.C., working, C7 — **Peak**
3 Wander plugs, Grid+, Grid−, Grid− — **Belling-Lee "Bow Spring"**
1 Battery cable, 6-way, 30 ins. — **Belling-Lee**
1 G.B. battery, 16½ volts
1 H.T. battery, 130 volts — **Drydex Type H1060 Special Quiescent Push-pull, Yellow Triangle**
1 Loud speaker, with transformer — **Celestion QPP19A**
Cabinet with wood panel, baseboard and battens — **Clarion Radio Furniture, 28/38, Mansford Street, Hackney, E.2.**
Systoflex, 1 oz., No. 22 tinned copper wire, etc.
Screws, 12 ¼in. No. 4 R/hd., 8 ¾in. No. 4 R/hd., 6 ¾in. No. 4 R/hd., 4 ¾in. No. 4 C/sk., 2 ¼in. No. 6 C/sk.
Valves, 2 Mazda Pen.220A 1 Mazda H.L.2 metallised.
Approximate cost (excluding valves, batteries, speaker, and cabinet), £3 15s.

The success of the Q.P.P. system depends to a large extent upon the correct design of the output transformer or auto-choke which links the speaker to the two pentodes. As explained in the recent article on this new development, one valve is idle while the other may have quite a heavy peak current, and the optimum load from plate to plate must be 18,000 ohms. These considerations demand a transformer with a rather larger core than is usually found in standard productions, but it is understood that, besides Celestion, the B.T.H.

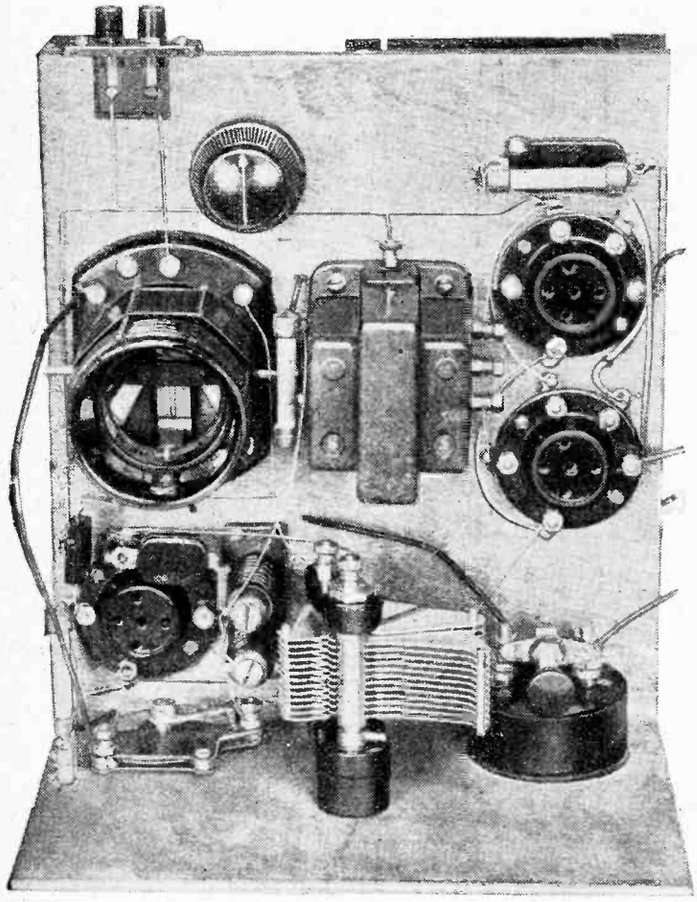


Showing the receiver alongside the moving-coil speaker and the H.T. battery, both of which have been specially developed for quiescent push-pull. On the left of the receiver panel can be seen the pick-up plugs and sockets.

The Quiescent Push-pull Two—

and Amplion Companies will be producing speakers with special Q.P.P. transformers.

For those who wish to make use of existing permanent-magnet moving-coil speakers with or without built-in transformers (moving-iron speakers can be used, but the results are not so satisfactory) a series of auto-chokes and output transformers are being manufactured by R.I. and Varley giving the necessary range of step-down ratios.

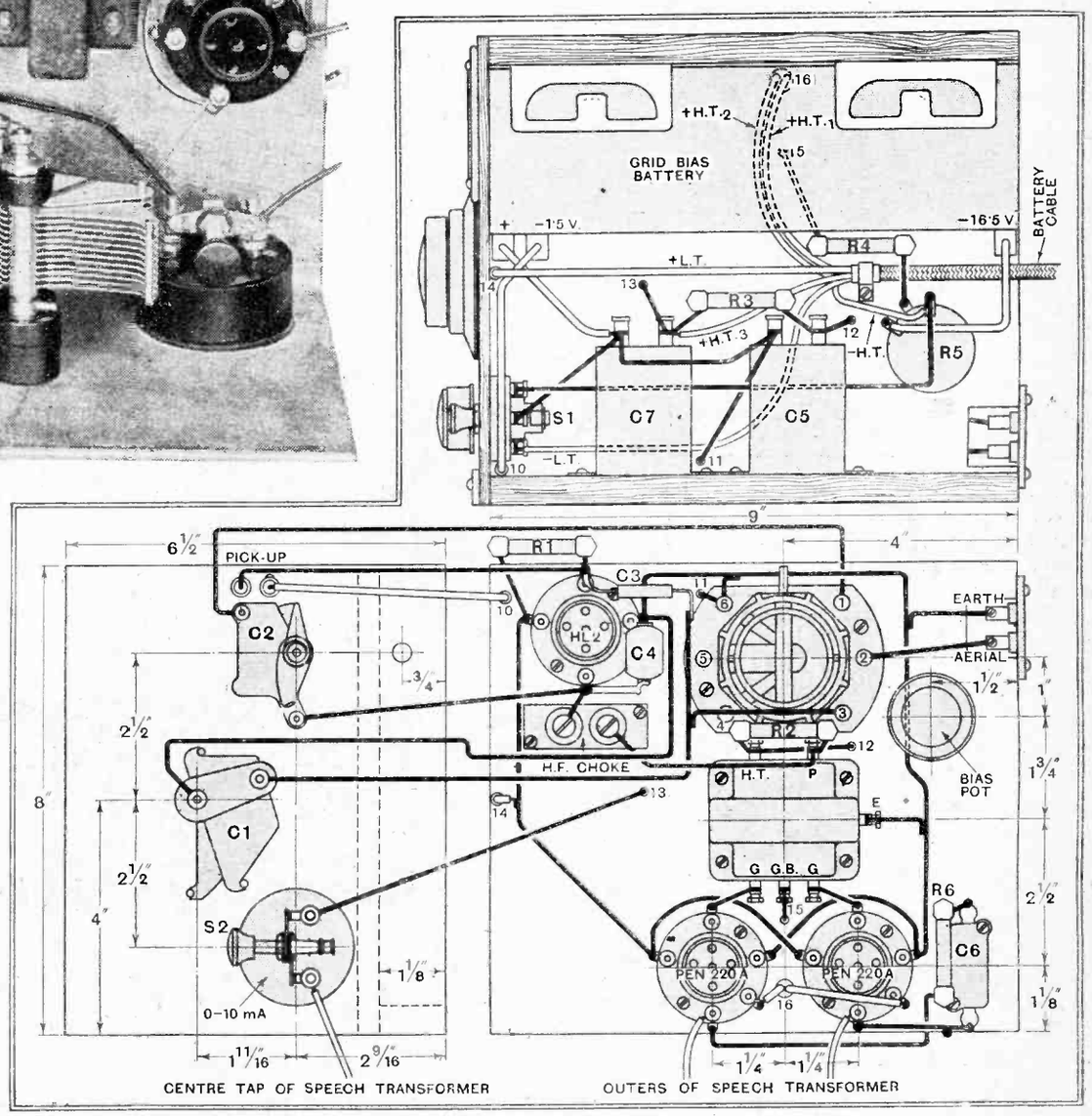


The wiring of the receiver is made extremely simple by the paucity of components and the clean lay out.

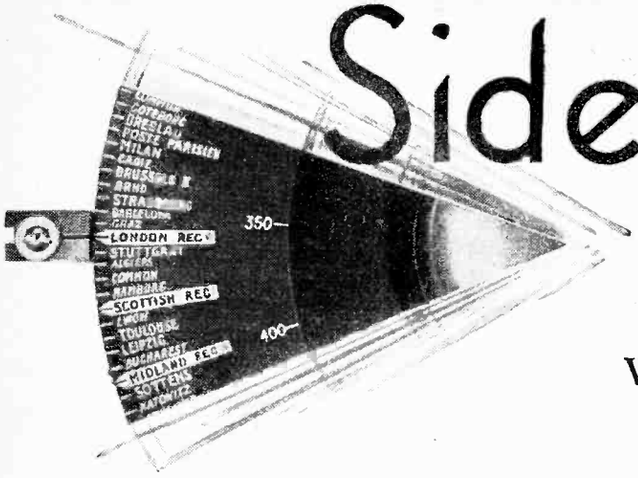
The construction of the set should present no difficulty as no component calls for any special skill in mounting. The switch which short-circuits the meter is held in position directly across the terminals of that component by two clips. Care must be taken to earth the core of the interval valve transformer, otherwise slight L.F. instability may be experienced.

When the wiring is completed, and the aerial, earth, and speaker connected, the initial adjustments must be carried out before the chassis is put into the cabinet. With the L.T. switch in the open position, connect up the bias and the L.T. and H.T. batteries, the H.T. wander plug being put into the 130½-volt socket and the two auxiliary grid plugs into the next two sockets separated by 1½ volts each. Turn the bias-battery potentiometer fully anti-clockwise, and then give it a very slight rotation backwards so that about 15 of the total 16½ volts negative bias are applied. Put the detector and one Pen 220A valve in their holders. Next close the L.T. switch, having previously opened the short-circuiting switch on the meter. If a reading of 2 mA. is obtained the auxiliary grid volts have the correct value for the pentode concerned. Should the reading differ from 2 mA. (and exact matching is not needed), the appropriate auxiliary grid-plug should be changed to another tapping on the H.T. battery, always switching off the set during this adjustment by breaking the L.T. It will be found quite easy to get the reading approximately correct with the H.T. tapping, and, then, with the help of a very slight movement of the bias potentiometer, a final correction can be made. The second pentode is now inserted into the vacant valve-holder and the first pentode removed. The set is switched on and adjustments made until the anode current is again 2 mA., but this time the bias potentiometer must not be touched. The meter must now be short-circuited by the switch, as otherwise its windings act as a common impedance in the anode circuits and a loud whistle is superimposed on the programme.

The set is now ready for test, and by loosening the aerial coupling, at the same time applying reaction, adequate selectivity can generally be obtained. The total H.T. consumption when the set is tuned off resonance is 6 to 6½mA., and the average consumption taken over a number of hours of listening about 8 mA. Much could be said regarding the remarkable power output, but the receiver can be trusted to speak for itself.



Practical wiring plan and dimensional data. The anodes, auxiliary grids and filaments of the valves are fed *via* a six-membered multiple cable.



Sideband Splash

When We Hear Music "Inside Out"

By R. W. HALLOWS, M.A.

THOUGH sideband splash is no new thing, it is only during comparatively recent times that its effects have grown so noticeable as to attract much attention. As a result of the widespread increase that has taken place in the power of transmitting stations, the interference due to sideband splash has now assumed such serious proportions that it must be regarded as one of the most pressing problems in present-day broadcasting. Unless, in fact, some means of combating the evil is found, high selectivity may defeat its own ends by giving prominence to a type of interference which is apt to be more objectionable than the kinds from which it brings relief.

Every recent year has witnessed increases in the numbers of high-powered European stations operating within the limits of the medium-wave and long-wave bands. The cry has therefore been for a higher and higher order of selectivity in the belief that tuning of knife-edge sharpness would enable large numbers of stations to be received completely clear from interference, except, of course, that due to atmospherics, for which there is still no known remedy. The present Prague Plan, with its 9-kilocycle separation (in a few cases 11 kilocycles) between stations, is based upon this assumption. A highly selective receiving set enables stations observing the provisions of the Plan to be received without intelligible jamming or interference from one another, and, by suitably regulating the cut-off frequency of the set, any heterodyne beat between their carrier waves can be rendered innocuous. But no sharpening of the tuning can get rid of sideband splash, a fact strongly emphasised in the recently issued report of the Radio Research Board.[1]

[1] Department of Scientific and Industrial Research. Radio Research. Special Report, No. 13.

There are, however, certain aspects of sideband splash of which no mention is made in this report. After reading it through, for instance, one might conclude that sideband splash must inevitably be noticeable whenever an attempt is made to receive one of two high-powered stations working upon adjacent channels. That this is not so any reader who possesses a modern super-heterodyne set can readily ascertain for himself. If, for instance, Moravska-Ostrava is tuned in whilst the London National station is in operation, or Stuttgart during a transmission from the London Regional, it may be found that there are considerable periods during which no splash is to be heard. Then suddenly the unwelcome stsip-stsip-stsip sounds break through into the wanted transmission.

MOST users of highly selective receiving sets must have experienced that very unpleasant form of interference in which intermittent splutterings from an unwanted transmission force their way through and become considerably more than a background to the wanted programme.

This interference, which is known as sideband splash, offers one of the most pressing problems in modern broadcasting.

By tuning rapidly from wanted to unwanted station, one soon discovers that, speaking generally, interference from sideband splash is experienced only when the unwanted station is transmitting speech. Occasionally, splash may be heard when the unwanted station is sending out music, and we shall refer to this a little later. It may be taken, in any case, that, so long as stations preserve the intervals between channels laid down by the Prague Plan, speech is a far more prolific cause of sideband splash than is music; or, to put it in another way, if speech were never transmitted by broadcasting stations we might even now regard sideband splash as an exceedingly rare and quite unimportant phenomenon.

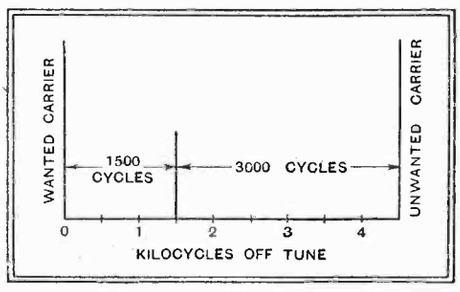


Fig. 1.—How "inside-out" music may be heard when two stations are working with small frequency separation. Here a 3,000 cycle note from the unwanted station provides a 1,500 cycle beat with the wanted carrier. High notes are heard as low notes and vice versa.

This may seem surprising at first sight, for the range of musical frequencies is greater than that of speech frequencies, and the intensity of sound when, say, a full orchestra is playing would appear to be much greater than that of ordinary speech. Why, then, should speech transmissions be worse offenders than those of music in causing this kind of interference?

A musical transmission can give rise to a curious and interesting form of sideband splash if the wanted and unwanted stations are working with a comparatively small interval between their carrier frequencies. This may be observed sometimes during intervals in the programme of Radio LL, when the unmodulated carrier alone is going out. Should Hamburg, 4.5 kilocycles away, be transmitting music, astonishing sounds may be heard. They are clearly due to music, but they are stranger far than even the wildest effects conceived by the most modern of modern composers. One is, in fact, hearing music inside out!

Splash Due to Speech

Sideband splash is caused by the beating of an unwanted side-wave with the wanted carrier. When the two transmitters have a 4.5 kilocycle (Fig. 1) separation a 3,000-cycle note from the unwanted causes a 1,500-cycle beat with the wanted. If the unwanted station transmits a high note, a low note is heard, and vice versa.

Take now the case of the London Regional and Stuttgart with a carrier frequency separation of 11 kilocycles. A 1,000-cycle note from London will produce a 10,000-cycle beat with Stuttgart's carrier, but since the modern super-heterodyne has usually a fairly sharp cut-off at 4,500-5,000 cycles in order to reduce heterodyne and mush effects there

Sideband Splash—

is no audible result. Clearly, though, a 7,000-cycle note from London may give rise (Fig. 2) to audible interference with Stuttgart, for in this case there is a 4,000-cycle beat, which is well within the range of a set that can lay claim to any approach to good quality in its reproduction.

In music frequencies of 7,000 cycles and more do occur, but those over 4,095 (C^4, the highest note on a full compass piano) are mainly harmonics and the attenuation of such frequencies is so great that they produce very feeble side-waves, particularly as the general sound level is kept down in the control room during musical transmissions. It is necessary to do this in order to avoid peaking, owing to the wide range of loudness that may be expected between *pianissimo* and *fortissimo* passages.

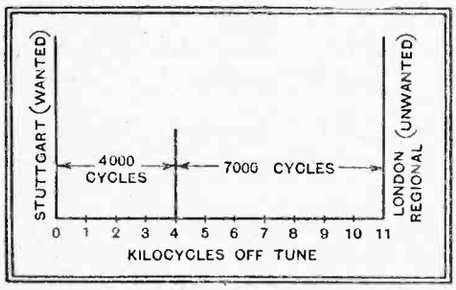


Fig. 2.—A strong 7,000 cycle note from the unwanted London Regional may cause a 4,000 cycle beat with the wanted Stuttgart. The text explains why the beat is audible when the unwanted station is transmitting speech but usually inaudible if it is sending out music.

Hence unless over-modulation is taking place from the unwanted station its musical transmissions do not cause audible sideband splash with the wanted even when the carrier frequency separation is no more than 9 kilocycles. In speech transmissions, though, certain factors of an entirely different kind present themselves. In the first place, unless, as rarely happens, some impassioned orator, conversant with every trick of the trade, is before the microphone, the variations in loudness are comparatively small. The voice of the studio announcer or the topical talker is neither raised nor lowered very much. It is thus accepted amongst broadcasting authorities all over Europe that peaking upon studio transmissions of speech is hardly to be feared, and for this reason it is the general practice to put up the sound-level in the control room when speech is in progress.

Sibilant Sounds

Secondly, speech can and does produce fundamentals—and very strong fundamentals—with frequencies of the order of 6,000 to 7,000 cycles. If the reader will pause for a moment to make a further experiment he will find that considerable energy is expended in the clear enunciation of many single consonants and consonant combinations. In making sibilant sounds such as "S" and "Z" air from the lungs is expelled forcibly between the almost closed teeth. Sounds such as "T," "D," "P," and "B" are produced by means of mild explosions. When, for instance, the sound "tat" is made the tongue is first of all pressed quite hard against the roots of the top teeth, from which position it is driven down by a sharp exhalation. For the final "t" it returns to its original position and is again driven sharply down. Repetition of words such as "strip," "preach," or "statistics" will serve to show how strongly certain consonantal sounds are produced.

With the general sound-level kept well up in the control room such sounds give rise to deep modulation of the carrier wave, and serious over-modulation is always a possibility. The result is that when, for instance, a 7,000-cycle speech sound is uttered a strong side-wave may occur from the unwanted station. In Fig. 2 the effect of this is seen when the unwanted station is the London Regional and the wanted station is Stuttgart. A sharp interfering sound with a frequency of the order of 4,000 cycles occurs.

Further experiments in rapid tuning from the wanted to the unwanted station will serve to show that sideband splash is at its worst when a speaker has clear and crisp enunciation, and that the "splashes" correspond with the sibilant or explosive consonant sounds that he utters. If he will forgive me for saying so, Dr. Walford Davies is a magnificent subject for such experiments when he is transmitting one of his music lessons for schools!

It is clear, then, that sideband splash severe enough to be offensive is due chiefly to speech transmissions by the unwanted station, and that it is the direct result of very deep modulation or even of over-modulation at high frequencies. Are we to conclude that the transmitting arrangements are entirely to blame for the unwelcome splutterings from which we suffer when using a selective receiving set? There is no question that a large share of the blame must rest with those responsible for the transmissions and that complete freedom from sideband splash will not be enjoyed unless and until European broadcasting authorities can come to some agreement (the forthcoming spring conference at Prague would seem to be an admirable occasion) to limit the extreme depth of modulation permissible upon speech transmissions. At the same time the receiving set cannot be completely absolved.

In the course of some recent investigations into the incidence and the severity of sideband splash I assembled a team of no less than half a dozen different superheterodyne receivers, some home-constructed and some of commercial make. It was clear from the outset that there were great differences in their performances. With some of them sideband splash reached noticeable proportions between very few adjacent pairs of stations; on the other hand, some showed distinctly offensive sideband splash between many such pairs. One set, rather surprisingly, brought out quite distressing splash from Stuttgart when the London Regional was being received at a range of fifteen miles. Against this last may be set the performance of *The Wireless World* "Monodial Super," which is remarkably free from sideband splash interference.

One is forced to the conclusion that the design of the receiving set plays a very important part, and experiments show that it is possible by attending to certain important points in the receiving set to reduce very greatly the effects of this kind of interference. To indicate how this may be accomplished is outside the scope of the present article, but an interesting and profitable field is opened both for the experimenter and for the designer of commercial receiving sets.

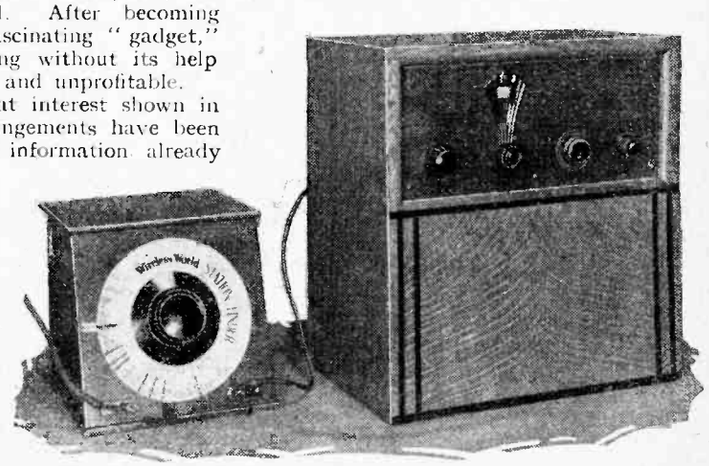
In Next Week's Issue:

MORE ABOUT THE STATION FINDER

THOSE who have already constructed the Direct-reading "Station Finder" (described last week) will be ready to agree that it does a great deal more than "double the interest of long-distance reception," as was originally stated. After becoming accustomed to this fascinating "gadget," foreign-station listening without its help seems to be dull, flat and unprofitable.

In view of the great interest shown in this new device, arrangements have been made to amplify the information already given, and, in next week's issue, further notes on construction and operation will be published. The finer points of adjustment and calibration, by means of which an even greater degree of accuracy than is strictly necessary may be ensured, will be dealt with.

As stated last week, there are a few receivers with which the original Station finder will not operate; the simple addition necessary for use with these sets will also be described.



The Station Finder is connected between the aerial lead-in wire and the aerial terminal of the receiver.

Practical HINTS AND TIPS

AIDS TO BETTER RECEPTION

Ganged Tuning on Long Waves

WHEN setting-up a gang-tuned receiver, it is usual to make initial trimming adjustments at the lower end of the medium waveband. On switching over for long-wave reception, it is generally assumed that all circuits will still remain in alignment, and that no further adjustment will be required.

To ensure this desirable state of affairs, there are two main requirements. The inductance values of the long-wave coils must be as accurately matched as on the medium band; this point everyone will appreciate. The second need is that the stray capacities of each circuit in the chain should be proportionally the same as on the medium band. These "strays" need not have the same absolute value on each band; indeed, they are almost certain to be higher on the long waves. The point is that any additional capacity transferred on switching over should have an identical value for each circuit; it is only in this way that the initial trimming adjustment can hold good on both bands.

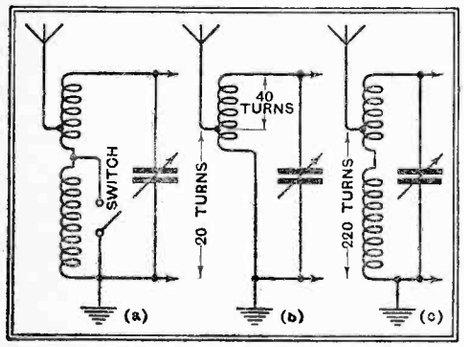


Fig. 1.—A type of dual-range tuning coil that is unsuitable for gang-controlled receivers. Equivalent circuits given in diagrams (a) and (b) show that the proportion of aerial turns is widely dissimilar for the two wavebands.

This being so, it will be appreciated that an aerial tuning coil such as that shown in Fig. 1 (a), can hardly be satisfactory in a gang-tuned set. Assuming that the medium-wave section be tapped so as to include one-third of its turns in the aerial circuit, the proportion of aerial capacity transferred to the tuned circuit will be quite small. But, on opening the switch for long-wave reception, the aerial will be connected across perhaps 90 per cent. of the total number of turns, with the result that nearly all its capacity will be additive to that of the tuning condenser.

Reasonably accurate alignment over both bands cannot possibly be maintained under these conditions. In order to ensure that the same proportion of aerial capacity is transferred on the long-wave band the tapping might be changed over, for reception on that band, to such a point on the long-wave section that the same proportion of turns are included in the aerial-earth circuit.

Similar precautions should be taken when a tapped tuned-anode or tuned-grid intervalve coupling is fitted. Even with double-wound transformers it is a matter of some importance that the ratio between primary and secondary turns should be sensibly the same on both wavebands.

Station Finder as Wave-trap

IN addition to performing the function for which it is intended, the Station Finder, described last week, will operate as a very efficient wave-trap. Although this method of eliminating interference has always a limited field of usefulness, it is often distinctly helpful, particularly when operating a set which is somewhat lacking in selectivity. For instance, when two more-or-less distant stations, working on adjacent channels, normally suffer from mutual interference, it may well be possible to receive either transmission with a substantially silent background by operating the Station Finder in the proper way.

With the instrument joined in the aerial circuit in the normal manner, the dial should be set so that the name of the interfering station registers with the index mark. At the worst, a useful reduction in the strength of interference may be counted upon, and, if conditions are favourable, it may become inaudible.

A Simple Cure

WHEN motor-boating or L.F. instability is encountered, it is often worth while, before applying more drastic measures, to try the effect of short-circuiting the grid circuit decoupling resistance, if one happens to be fitted. This simple expedient may cure the trouble by allowing enough anti-reaction feed-back to neutralise the pro-reaction feed-back which caused the trouble.

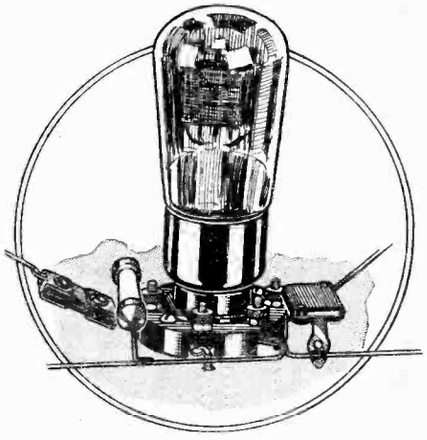
As grid-circuit decoupling is often provided merely to prevent attenuation of low notes, it may seem that this simple cure, if it be effective, will have been achieved only by making sacrifices in the bass register. It does not of necessity follow that this will be so; for reasons that need not be explained here, there is a distinct possibility that the L.F. reaction which was responsible for the original trouble will provide enough compensation, and so well-balanced reproduction may be obtained.

Suspended in the Wiring

AMONG a certain section of wireless amateurs, there is an understandable prejudice against the modern practice of securing components in position merely by means of their connecting wires, with no other form of mechanical support. It is argued that this method of construction is slipshod, unworkmanlike and, more serious still, is open to technical objections on the grounds of permanence. In a receiver with single-dial tuning, it is obviously necessary that everything should be sufficiently rigid to prevent appreciable changes in stray capacity.

When one comes to examine the matter more closely, and from a strictly practical point of view, it seems quite certain that these objections are almost baseless. Given reasonable care and the exercise of common sense, there is no valid objection to anchoring light-weight parts such as resistances and fixed condensers by their connecting leads; in some cases, a definite reduction in stray capacity will result, and so the waverange covered by the set will be increased. For instance, it is not always realised that a detector grid-condenser of the flat type, wher screwed to a metal chassis or baseplate, may add many micro-microfarads to the tuned circuit with which it is associated.

On the score of permanence, a careful test shows that the greatest mechanical displacement likely to occur in a properly constructed set will bring about a negligible change in capacity; so little, indeed, that it would only assume any importance in such an instrument as a wavemeter.



With no other support than their connecting leads; illustrating a tendency in receiver construction.

There is, of course, a limit to the weight of components that may be suspended by their leads, as anyone blessed with the mechanical sense will realise when this limit is approached.

Reverberation *and the* Loud Speaker

Acoustic Control in Large Rooms

By W. H. O. SWEENY

ALTHOUGH meticulous care is given to the design of modern amplifying equipment to reduce distortion to the very minimum, the question of the mutilation of sound waves after they leave the loud speaker is often hardly considered at all. It is pointed out in this article that there are a number of causes of distortion in large rooms of poor acoustic properties, the most serious of which is insistent reflection or reverberation. Happily, in most cases this can be overcome.

THERE is an old adage providing that the weakest link determines the strength of the chain, and it would be difficult to find a more apt example of this ancient saw than that represented by a modern broadcast receiver. It somehow seems a pity that so much attention should be paid to the development and design of high-class receivers and reproducers, when the question of what happens to the sound waves after leaving the loud speaker is scarcely considered at all. It is true that this matter hardly comes within the province of the designer, but the fact remains that, in many more cases than is generally realised, the careful fostering of the original waveform of the broadcast sounds right up to the moment that they leave the loud speaker is rendered quite useless by the violent distortion to which they are subjected before they finally reach the ear. This distortion is, fortunately, not as serious as the above statement would lead one to believe, due chiefly to the amazing tolerance of the human ear. It is, nevertheless, of sufficient moment to warrant some attention as listening conditions differ somewhat widely.

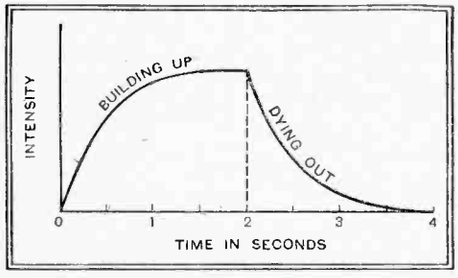


Fig. 1.—Graphical representation of the effect of cutting off suddenly a sustained sound.

In the case of small adequately furnished rooms the question of acoustic control hardly arises; the position of the loud speaker is the only point of consideration, this being more usually governed by domestic requirements. It is when a large room, such as a schoolroom, or small hall, is encountered that the first difficulties are recognised. Everyone has, at some time or other, been present in an empty hall, or in an unoccupied house, and has instantly noticed the "hollowness" present. Such a hall is referred to by most people as being "echoey," although, as will be shown later, echoes form but a very small proportion of the phenomena. The most commonly known instance of rooms afflicted with the above symptoms is the school classroom, and in these days of extensive school broadcasts, when the curriculum of the majority of schools includes such broadcast lessons, any attempt to improve the acoustic qualities of the classroom should merit some attention.

Before describing any practical methods of securing acoustic control it would be helpful to consider the different forms of distortion to which the sound waves are subject.

Causes of Distortion

If a single sound of very short duration be produced in a room the paths taken by the waves assume initially the form of concentric circles, with the source of sound as the focus. These circles are ever widening until the waves strike the walls of the room. They are then partly reflected in all directions, partly transmitted through the walls, and partly absorbed by the surfaces. At ordinary temperatures the sound waves travel at the rate of about 1,120ft. per second, and it will readily be realised that at the end of, say, half a second the waves have been reflected many times from the different walls of the room, and have travelled many feet. The energy of the wave is meanwhile converted into heat by constant reflection and transmission, and eventually dies out. This promiscuous reflection has the advantage that it readily results in the room becoming comparatively evenly filled with the sound, with consequent even distribution of loudness; It may, however, in certain circumstances, be a definite disadvantage. If the walls of the room happen to be of a hard non-porous nature the waves will be reflected many times, and over a long period, before they eventually die away. This insistent reflection is known as reverberation, and is probably the greatest of the evils which have to be combated.

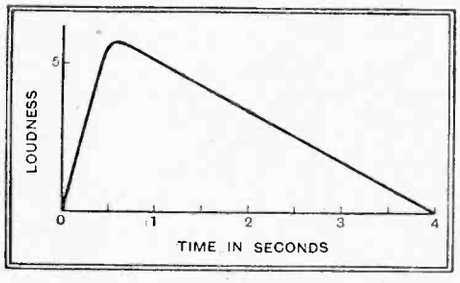


Fig. 2.—The effect on the ear of the sudden cutting off of a sustained sound, plotted logarithmically.

It will readily be seen that if a succession of sounds is produced in a room possessing excessive reverberation each sound will, by virtue of the long period required for dying away, become merged into the other, and dire confusion will result. It has been found by experience that much more reverberation can be tolerated for music than for speech—in fact, a certain amount is definitely desirable to give life to the music. With speech, unintelligibility will result. Before dealing with reverberation in greater detail the remainder of the causes of acoustic distortion should be understood. When a sound is produced, sustained, and then suddenly cut off, the result may be represented graphically, as in Fig. 1. This curve does not give an entirely accurate idea of what happens from the point of view of what is heard by the ear. Fig. 2, plotted on a logarithmic scale, shows the effect as noticed by the ear.

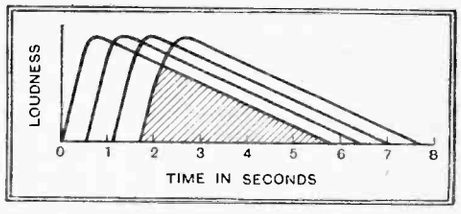


Fig. 3.—If four words are spoken in a reverberant room, the effect may be as shown in this illustration. The shaded portion is the overlap between first and last words and indicates unintelligibility

It will be seen from the two graphs that after the sound has reached a maximum the intensity falls rapidly at first, and more gradually later, although, to the ear, the decrease is gradual and constant. If, say, four words are spoken in succession in an empty and reverberant room the result may be shown graphically as in Fig. 3. The shaded portion shows the amount of overlap between the first and the last words, and is an indication of unintelligibility. If the same words are spoken in a more heavily damped room the result is as in Fig. 4, and it will be seen that the overlap, and consequent unintelligibility, is much less. It should be noted, incidentally, that, contrary to popular belief, the damping of the room has little effect on loudness.

Another phenomenon in a lightly damped room is that of resonance. That

Reverberation and the Loud Speaker—

is, the walls, and the volume of air contained within them, have a resonant frequency which will have a pronounced modification on any note of the same frequency sounded within the room. With regard to the air content, the resonant frequency is raised as the volume is reduced. When the walls, or solid contents, of a room resonate to any particular tone which is produced, the loudness of that tone is diminished owing to the absorption of energy by the vibrating bodies.

The interior of one of the listening rooms at Broadcasting House, the headquarters of the B.B.C., where great care has been taken to provide realistic reproduction.

Echoes and Interference

Echoes form an acoustic fault which is confused by many people with reverberation. An echo is the reflection of a sound from a surface, and becomes noticeable only when the reflected sound is heard more than about one-sixteenth of a second after the direct sound. It differs from reverberation in that the latter is the constant reflection and attenuation of a sound over a definite period, this period being known as the time of reverberation. An echo is one single reflection, which may be heard at a definite time after the direct sound (in extreme cases up to six seconds or so). A further phenomenon is known as interference. When a reflected wave strikes a direct wave an intensification results at that spot, while in other spots a corresponding reduction in intensity may be noticed. This effect is similar to that of standing waves produced by a pure tone, and so readily noticed in the case of the B.B.C.'s tuning note.

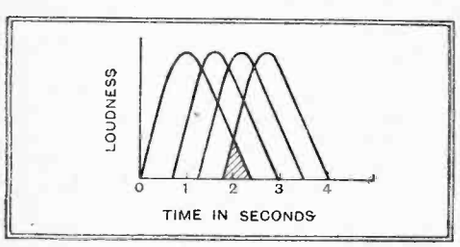
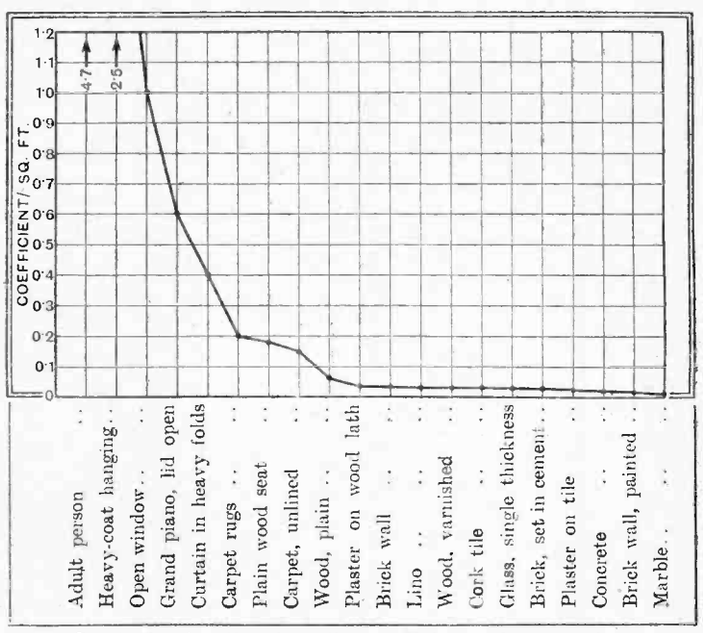


Fig. 4.—The same conditions as in Fig. 3 but in a heavily damped room. The overlap and unintelligibility are seen to be less.

Of the above acoustic faults the worst, as has been indicated, is reverberation. If reverberation is excessive satisfactory or even intelligible listening is impossible. If, however, the time of reverberation is reduced to a suitable figure the other faults present usually become tolerably insignificant.

When a sound wave is set up in a room it spreads outwards to the walls, as has been pointed out above. Although the attenuation is obvious to the ear, the energy as represented by the sound is not destroyed, but converted to some other form of energy. On conversion, the energy ceases to be sound, thus producing attenuation, and ultimate silence. Part of the energy is used up in setting the walls in vibration, and part in friction, thus producing heat. If the walls of the room are hard and smooth the time taken for the conversion of the energy to heat is longer than if the walls are soft and porous. This is due to the longer time occupied by the successive reflections. It seems obvious, therefore, that, in order to produce rapid attenuation, it is necessary to have walls the surfaces of which are soft and porous.[1] Thus, in a room with hard plaster walls it is necessary to line the hard surfaces with a porous absorbing material or, at least, to introduce a sufficiently large area of absorbent to produce the required rapid conversion. In this connection the effect of bringing upholstered furniture into an empty room is well known.



Graph showing the absorption coefficients of commonly used materals.

Reverberation Periods

At this stage the obvious requirement is to know beforehand exactly how much absorbing material to introduce into a given room, and to determine the nature of the material. The late Professor Wallace C. Sabine, of Harvard University, was responsible for a great amount of work on this subject, and this research has made possible the ease with which problems such as this can be tackled to-day. His first important contribution was a formula showing the relation between the time of reverberation of a room, its volume, and the absorption power of the different materials in the room.

It is as follows: $t = 0.05\ V/a$, where t = time of reverberation in seconds, V the volume of the room in cubic feet, and a the absorption power in absorption units.

If the optimum time of reverberation for a room be known, then it is possible to calculate the exact amount of absorption needed.

Dealing first with the optimum time of reverberation, this naturally varies with the size of the room and the nature of the sounds to be reproduced in it. For speech a very short period is required, and for music a rather longer one. In school classrooms, where reproduction of talks is more called for, a reverberation period of considerably less than a half-second should be aimed for, while if music be

[1] Lord Rayleigh has shown that the sound waves enter the pores and are reflected from side to side of the inner surfaces, thus producing heat by friction.

Reverberation and the Loud Speaker—

the chief object a period of approximately one second, or slightly less, would be acceptable, depending on the size of the room. This refers to normal-sized class-rooms. Larger rooms and halls require a longer period. As an indication, for a compromise between optimum conditions for speech and music, a room of 1,000 cu. ft. requires a period of about 0.8 second, one of 8,000 cu. ft. a time of just over 1 second, and one of 27,000 cu. ft. a reverberation of 1.3 seconds. These times are about correct, assuming that the number of listeners in the room varies between the maximum and one-third capacity. Having determined the optimum reverberation time and measured the volume of the room, Sabine's formula will give the number of absorption units required.

The number of absorption units in any quantity of material is given by the product of the area, in square feet, and the coefficient of absorption. Thus, if we know the coefficients of all the materials in the room, the total number of absorption units present may be readily computed, and, from Sabine's formula, either the reverberation period may be worked out or the necessary additional absorption units to produce a given period may be calculated.

Practical Example

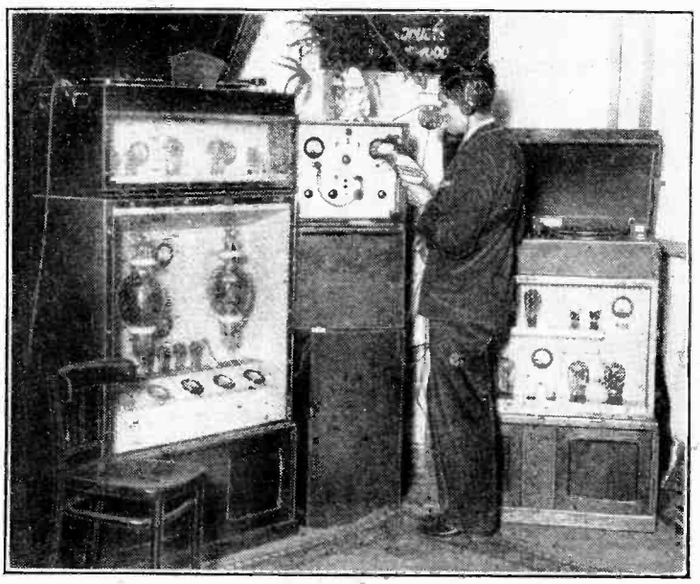
To assist in applying the formula to practical examples a graph has been prepared showing the absorption coefficients of all the most commonly used absorbing materials, also of most surfaces met with in practice. These figures have been compiled from the results of researches by most of the well-known acoustical authorities.

A practical example is perhaps the simplest way of showing how easy it is to apply the formula. In this case the volume of the room was found to be 3,360 cu. ft. Tabulating the areas of the various surfaces with their absorption units gave the following:—

Plaster	1,000 sq. ft.	@ 0.027	= 27	units
Wood (varnished)	100 ,, ,,	,, 0.03	= 3	,,
Glass	96 ,, ,,	,, 0.027	= 2.6	,,
Linoleum	204 ,, ,,	,, 0.03	= 6.1	,,
Chairs	4 ,,	0.1	= 0.4	,,
Piano	1 ,,	0.6	= 0.6	,,
Table	1 ,,	0.2	= 0.2	,,
Table	1 ,,	0.1	= 0.1	,,
Audience	3 ,,	4.7	= 14.1	,,
Two heavy coats on rack	,,	2.5	= 5	,,
			59.1 units	

With regard to the above list, it will be noted that certain individual objects have been treated as a whole, i.e., the chairs, piano, tables, and coats have been estimated as possessing a definite number of units each. In the case of one table a cloth was present; the piano was a horizontal grand, with the lid usually open. With the lid shut the absorption might be reckoned as being something less than 0.6—say, 0.4 units. From the volume of the room a reverberation period of 1 second was selected, this being considered to be the most favourable figure for music—for the reproduction of which the room was being used. Sabine's formula gave $1 = 0.05 \times 3{,}360\ a$, i.e., $a = 0.05 \times 3{,}360$ divided by $1 = 168$ units. There were already 59.1 units present, and therefore 109 units were still required. It was decided to use sheets of pulp board having a coefficient of 0.3, i.e., $109/0.3 = 363$ sq. ft. were needed.

In calculation of acoustic problems attention should be paid to the number of persons likely to be present in the room. The absorption offered by the clothing of an average person amounts to about 4.7 units, and is relatively higher than that given by anything else. It is usually safer to base all calculations on one-third maximum capacity. In this connection mention should be made of the Concert Hall in Broadcasting House. This has a reverberation period of slightly less than 2 seconds, and has a seating capacity of 700. The B.B.C. claims that the reverberation period remains practically unaltered whether the studio is empty or full. Although it is at first somewhat difficult to accept this from a theoretical standpoint, it is conceded that, by giving each chair a very large absorption factor, this condition could be closely approached. The chairs should be designed so that when they are occupied the whole of the absorption surfaces are hidden by the clothing of the occupier, and all the parts which remain in view should possess very little sound-absorbing powers. Thus, if the absorption units of each chair approached the figure possessed by the occupier, i.e., 4.7, the conditions claimed would be obtained. It is probable that this is so, since, when seated, a clothed person exposes only part of his clothing to the sound wave, and it is possible that the number of units then approach the figure 3, which could be obtained by a suitably padded seat.



A CIRCUS SIDELIGHT. Tannoy public-address amplifiers supplying the giant loud speakers at Bertram Mills' Circus at Olympia. The ½-kW. amplifier on the left delivers 180 watts of undistorted power and is used both for announcements and the relaying of bands.

NEW BOOKS

PHOTOCELLS AND THEIR APPLICATIONS (2nd edition), by V. K. Zworykin, E.E., Ph.D., and E. D. Wilson, Ph.D. Published by John Wiley and Son, Inc., at 18s. 6d.

A large portion of this book is devoted to the history of the development of photocells, and the experiments of the pioneers of this branch of electrical research are described in some detail. Both vacuum and gas-filled photocells are treated, as well as the photo-conductive and photo-voltaic types, and the theoretical considerations underlying their design are discussed at some length, and illustrated by details of commercial types. Having thoroughly dealt with photocells themselves, the authors proceed to their applications, and, in addition to citing numerous practical uses, they give details of suitable amplifiers and correction networks for sound recording and television work.

The book concludes with a résumé of the probable future trend of development; it is profusely illustrated, and its 321 pages are remarkably free from printers' errors. An exceedingly useful appendix is included.

Les Radio-communications Modernes, by Pierre David, D.Sc. A short summary, for non-technical readers, of the Propagation of Wireless Waves, Valves, Spark, Arc and Valve transmission, Amplifiers, Receivers, etc., with chapters on Radio Communication, including Broadcasting, Direction Finding, Photo-telegraphy, and Television. Pp. 150 +16, with 72 illustrations and diagrams. Published by J.-B. Bailliere et fils, Paris. Price 10s.20.

The Music Seller Reference Book, 1932-1933. A list of gramophone records and sheet music published since September 1st, 1931, and addresses of the manufacturers and suppliers of gramophones, radio-gramophones, and accessories. Published by Evans Bros., Ltd., Russell Square, London, W.C.1.

Small Transformers. Their Design and Construction. By A. H. Avery. In addition to practical instructions in building small mains transformers of the type used in wireless receivers, this booklet gives diagrams for the usual tests, and devotes two chapters to various types of rectifier. Pp. 56, with 46 illustrations and diagrams. Published by Percival Marshall and Co., Ltd., London. Price 9d.

NEWS of the WEEK

Current Events in Brief Review

Egypt Calling

CAIRO is to have a 20-kW. broadcasting station under the control of the Posts and Telegraphs Department. The station should be ready for testing in the autumn.

Laughing Intervals

OUT of an assortment of varyingly intelligent suggestions *Poste Parisien* has selected a new interval signal, namely, the sound of a coach horn.

Among the ideas submitted were the cooing of a dove and a burst of feminine laughter.

No Broadcast Apologies

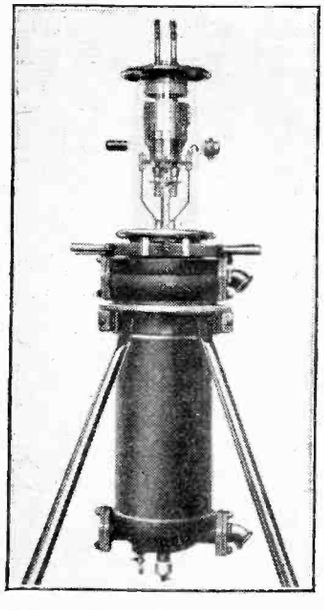
LISTENERS all the world over will sigh with relief at the findings of a Vienna court in a recent slander case. The plaintiff had demanded that the defendant should broadcast his apologies for the offensive remarks, but the Court ruled that the Press was an adequate medium.

Spain is Up to Date

SPAIN is determined that school children shall not be victimised by inferior radio reception. The Minister of Education has ordered 400 sets of an approved pattern for installation in village schools, and a project is under discussion for equipping all educational establishments with first-class receivers.

German Licence Increase

GERMAN licensed listeners on January 1st numbered 4,307,722, an increase of 326,870 over the figure for twelve months earlier. It should be noted, however, that free licences issued to the unemployed amounted to 512,149, as compared with 283,960 on January 1st, 1932, leaving a net increase in paid up licences of only 98,689.



FOR DROITWICH.—One of the new Marconi C.A.T. 14 super-power transmitting valves for use at the new long-wave station. It stands over 4 ft. high.

'Phones in the Dormitory

"WIRELESS is wholly a good thing. At my own school every boy has earphones by his bedside, and can listen-in to news, good music, and the programmes of foreign countries."
—Mr. J. Howard Whitehouse, Warden of Bembridge School, in an address at University College, London.

Birth of Public Radio Telephony

SUNDAY last, January 15th, was the tenth anniversary of the first official radiotelephony conversation transmitted from Rocky Point, America, to New Southgate, London. It was following the success of these tests that the British Post Office decided to open a commercial service with the United States.

Encouraging the Home Constructor

IRISH listeners are rejoicing over the new era of cheaper wireless sets consequent upon the reduction in import duties. Complete transmitters and receivers are now admitted into the Irish Free State on payment of a 50 per cent. *ad valorem* duty. On loud speakers and component parts the duty is 25 per cent.

Radio Paris as State Station?

AFTER several weeks of rumour it now appears fairly certain that the French Government will agree to purchase *Radio Paris*, the famous French broadcasting station at Essarts-le-Roy. According to our contemporary, *Le Petit Radio*, the offer has been made by the owners of the station, the Compagnie Française de Radiophonie, in consequence of the voting of the necessary sums for the erection of a 100-120 kW. station on the outskirts of Paris to replace the Eiffel Tower station.

The indications are, therefore, that the French Government may adapt *Radio Paris* to transmit on the higher power, that the proposed new station may be indefinitely shelved, and that Eiffel Tower may cease to function as a broadcasting centre.

Gangsters Only

THE popular American pastime of listening-in on the police wavelengths received a serious threat the other day when a Bill was introduced into Congress seeking to forbid wholesale listening on these short waves. However, listeners breathed a sigh of relief when they examined the phraseology of the Bill, which ran: "It shall be illegal to pick up police signals *to evade the law*."

In other words, gangsters fleeing from justice are forbidden to tune in the police messages. This will be a sore handicap.

The Bells of Europe

BELLS and carillon peals are usually a success on the ether. The German broadcasting authorities are now suggesting a special Easter feature in which each European country would broadcast the sound of its most famous bells for the rest of the Continent to hear. Thus Germany might be represented by the bells of Cologne Cathedral, France by Notre Dame, Britain by York Minster, and so on.

Lectures on A.C.

A COURSE of ten lectures, with demonstrations, on "Alternating Currents and Electrical Oscillations" is to be given by Mr. D. Owen, B.A., D.Sc., F.Inst.P., at the Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.C.3, commencing on Tuesday, January 31st.

Life-saving at 7,000 Miles

FICTION is outdone in a tale, the truth of which is vouched for by the American Radio Relay League. A New Zealand amateur was recently picking up a Morse message transmitted on a mobile short-wave station, K7UT, operated 7,000 miles away by Clyde De Vinna, cinematographer on a film expedition to the far North.

After a time De Vinna's Morse grew halting and incoherent, and finally stopped. The New Zealand amateur, guessing that something was amiss, got in touch with an Alaskan amateur, who notified the authorities at Teller, near the cinema camp. Within twenty minutes De Vinna was located; he was found in his hut lying unconscious from the effects of carbon monoxide gas generated by a coke fire. The rescue party had arrived just in time.

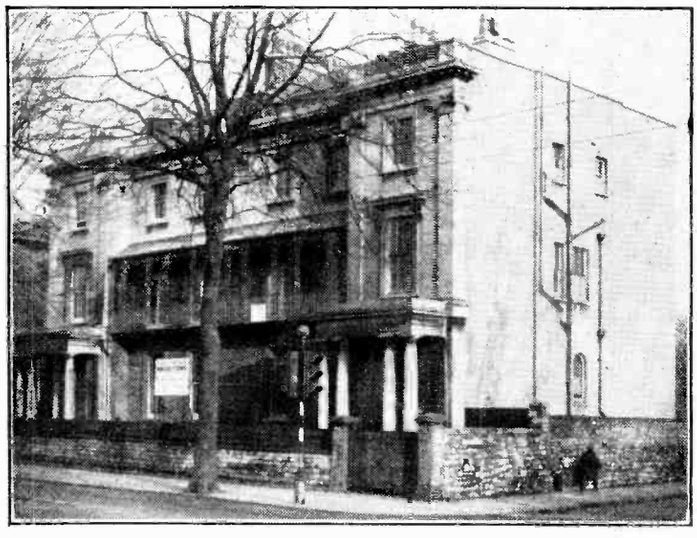
New B.B.C. Transmitter

THE B.B.C. has placed an order with the Marconi Company for a 100-kW. broadcasting transmitter to be installed at the new long-wave station at Droitwich, replacing Daventry National.

The transmitter will incorporate "series modulation" and three new Marconi high-power valves, each capable of dealing with a telephony input of 150 kW.

In series modulation, which considerably simplifies high-power station design, the modulator and the modulated power stage are placed in series across a constant voltage supply. The resistance of the modulator is so adjusted by means of grid potential that the total voltage is divided between the two units. The modulated amplifier can be considered as a constant resistance, whereas the modulator represents a resistance variable by the variation of its grid potential. A change in the modulator resistance, therefore, will cause the voltage across the modulated amplifier to vary in a manner directly proportional to the variations in the grid circuit of the modulator.

As this method of modulating the plate voltage of the radio frequency valve dispenses with any iron core choke or transformer it can be applied to a transmitter with valves of considerable power, while maintaining a high degree of linearity and wide range of frequency response. By this means the stages of modulated amplification required can be reduced to only one, with a consequent reduction in harmonic distortion.



WESTERN REGIONAL. Two houses in Whiteladies Road, Bristol, which the B.B.C. will convert into a "Broadcasting House" serving the West region. We hope that Mr. Ashbridge has observed the traffic signal and is making suitable arrangements to cope with the radiations therefrom!

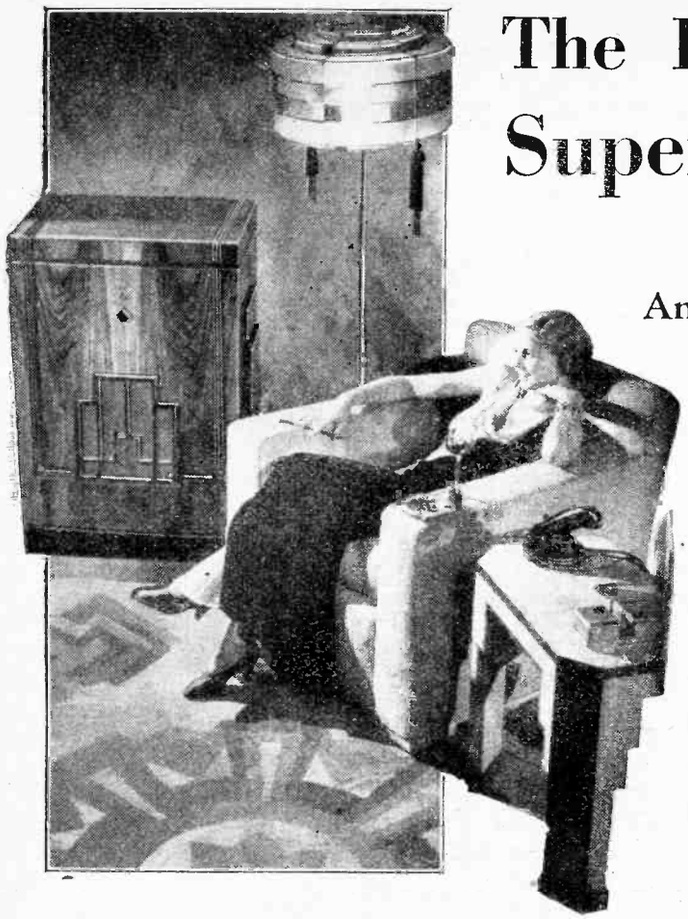
Cutting Off "The Juice"

MAINS sets will never be universally popular in France while small municipalities like Fleury-les-Aubrais (Loire Department) cut off the current between 10 a.m. and mid-day in order to attend to the generating plant.

The H.M.V. Superhet Autoradiogram

MODEL 532

An A.C. Mains Radio-Gramophone



THE radio-gramophone can no longer consist of a receiver to which has been added a gramophone pick-up and turntable; it must now be a complete whole, in which each component part has been designed specifically for the particular purpose which it is called upon to perform. The latest and most ambitious product of the Gramophone Company fulfils in every way this definition; and although it is at first glance similar to their earlier model, closer examination reveals numerous changes which have been made in accordance with recent developments.

Four-Unit Assembly

A unit construction has been adopted, and these units are assembled into the cabinet, which thus becomes rather more than a mere container. They are four in number, and comprise the receiver chassis, the power chassis, the loud speaker, and the automatic record changer assembly.

The receiver chassis contains six valves arranged to function as an H.F. stage, first detector, oscillator, two I.F. stages, and an anode bend second detector. The amplifying valves are all of the variable-mu type, and the radio volume control operates by varying their bias voltages. The H.F. valve is preceded by a two-stage band-pass filter of the inductively coupled type, and it is transformer-coupled to the first detector; there is thus a total of three tuned pre-selector circuits. As a result, the receiver is exceptionally free from undesired responses, and even on the local station second-channel interference is practically negligible. The ganging of the oscillator circuit is arranged with the aid of a condenser having specially shaped plates, so avoiding complex padding systems, and since the coils are unscreened the coupling between the oscillator and first detector circuits is obtained by the simple expedient of placing the H.F. transformer and the oscillator coils in their correct relative positions. The first I.F. transformer is connected in the anode circuit of the first detector; it is of the band-pass type, and a switch is arranged so that resistances can be connected to both primary and secondary circuits when it is desired to reduce the amplification and broaden the response curve for local reception.

The two variable-mu I.F. stages are each coupled by similar transformers, so that there is a total of six tuned I.F. circuits. With the three pre-selector circuits, therefore, the signal must pass through nine circuits on its way to the second detector, and in consequence the adjacent channel selectivity is of an exceedingly high order.

The second detector is of an unusual type, since a very low resistance valve, actually an ML4, is used in the self-biased condition to act as an anode bend detector. A most complex filter is connected in its anode circuit in order to prevent any leakage of I.F. currents which might introduce instability and cause undesired responses on the long waveband.

The output of the detector is taken to the power chassis, in which the first valve is a low-frequency amplifier, and is employed on both radio and gramophone. The coupling between the detector and the L.F. stage is by resistance-capacity, and on gramophone the valve is fed from the pick-up through a potentiometer connected to act as the volume control. This valve is resistance-transformer coupled to the output stage, which consists of two PX4 valves in push-pull, and it is interesting to note that independent biasing is used for these. The moving-coil speaker is, of course, fed through a transformer.

The smoothing equipment is exceptionally generous, and the mains transformer itself is of unusually large dimensions. The output of the valve rectifier is taken through a tapped choke, connected in a special hum neutralising circuit, to the

FEATURES

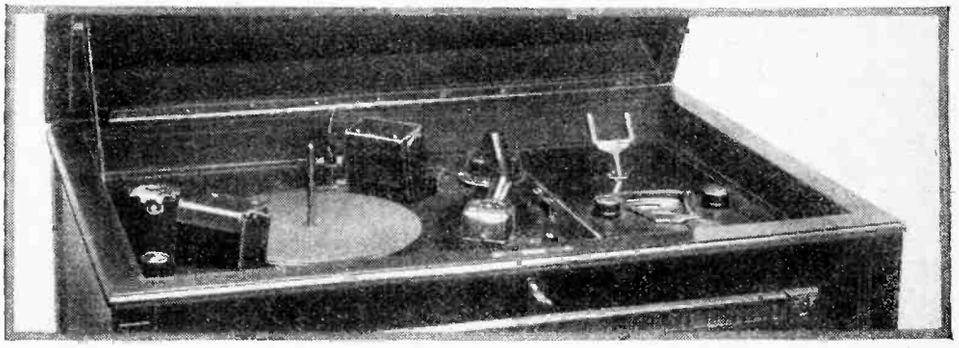
Circuit.—*Ten-valve superheterodyne with three tuned pre-selector circuits and six I.F. circuits. Preliminary variable-mu H.F. stage and two variable-mu I.F. stages, with a two-valve frequency changer. Push-pull output to the energised moving-coil loud speaker. All A.C. operation.*

General.—*Automatic record changer in the gramophone equipment, and sound-proof lid to the cabinet. Provision for the use of an external speaker with or without the built-in model. Floating chassis construction.*

Controls.—*(1) Single tuning control with calibrated and illuminated dial. (2) Volume control operative on both radio and gramophone. (3) Combined on-off, radio-gramophone, and wave-change switch. (4) Local-distance switch. (5) Tone control. (6) Gramophone motor switch. (7) Record changer switch. (8) Record rejector button.*

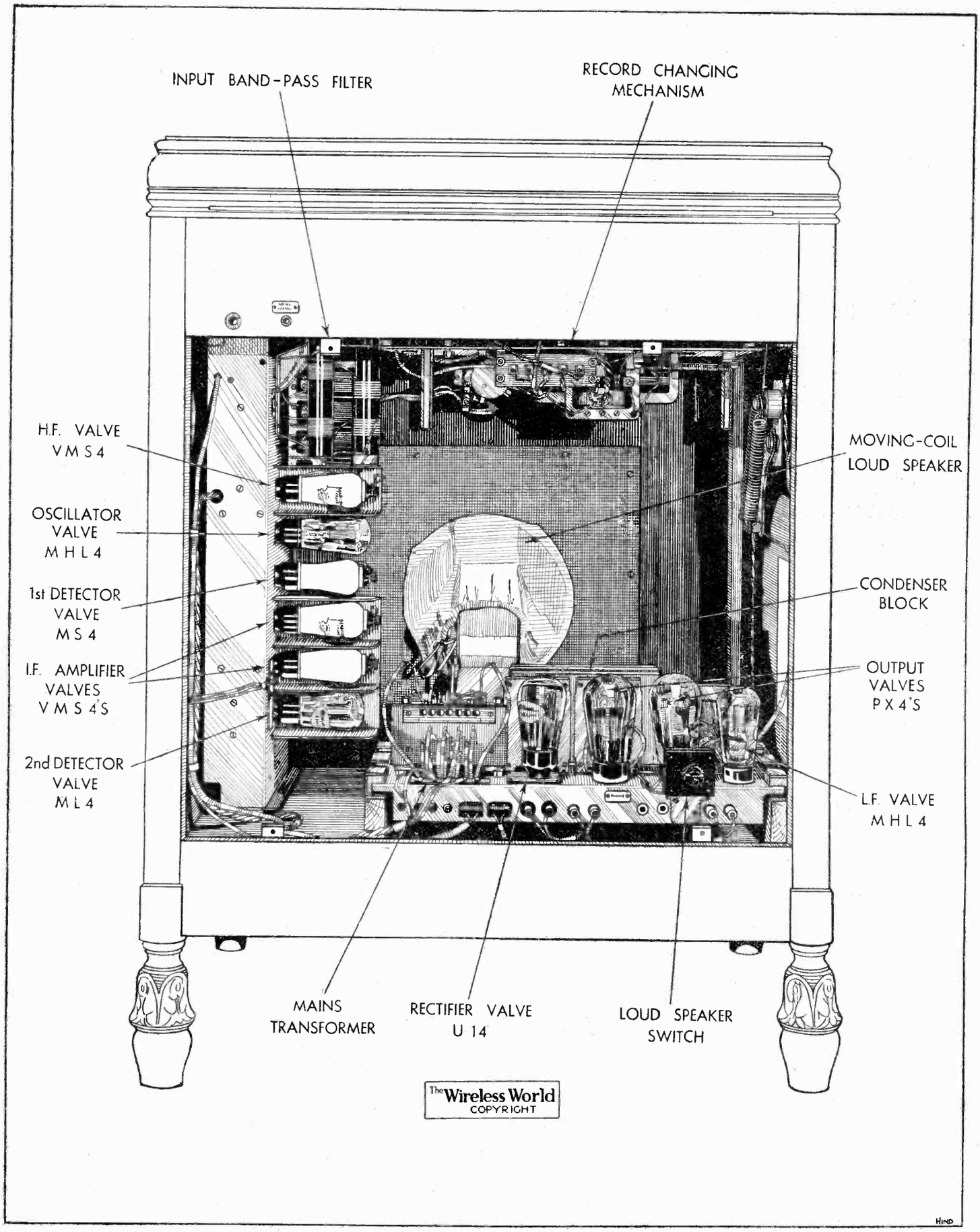
Price.—*80 guineas in standard cabinet; 95 guineas in special modern style cabinet, illustrated on this page.*

Makers.—*The Gramophone Co., Ltd., 363-367, Oxford Street, London, W.1.*



View of the motor board showing the automatic record changer.

A Highly Developed Radio-gramophone



Showing the rubber-suspended chassis of the H.M.V. Superhet Autoradiogram.

The H.M.V. Superhet Autoradiogram—

field winding of the moving-coil loud speaker, where, in providing the necessary energisation, the current is still further smoothed. The current for the output stage is then tapped off, but that for the earlier valves passes through another choke; there are thus three smoothing chokes, and, as might be expected, the hum level in the output is inaudible.

The automatic record changer is of the usual H.M.V. pattern and is extremely simple to operate. When loaded to full capacity it is capable of playing eight 10 or 12in. records consecutively. The different sizes must not be mixed, of course, and only one side of each can be played. A push button on the front of the cabinet allows any unwanted record to be rejected, and the volume control is also conveniently mounted outside the cabinet. The lid is fitted with an automatic closing device, and it is well packed with felt to make it soundproof and to prevent any pick-up chatter from being audible.

Excellent Performance

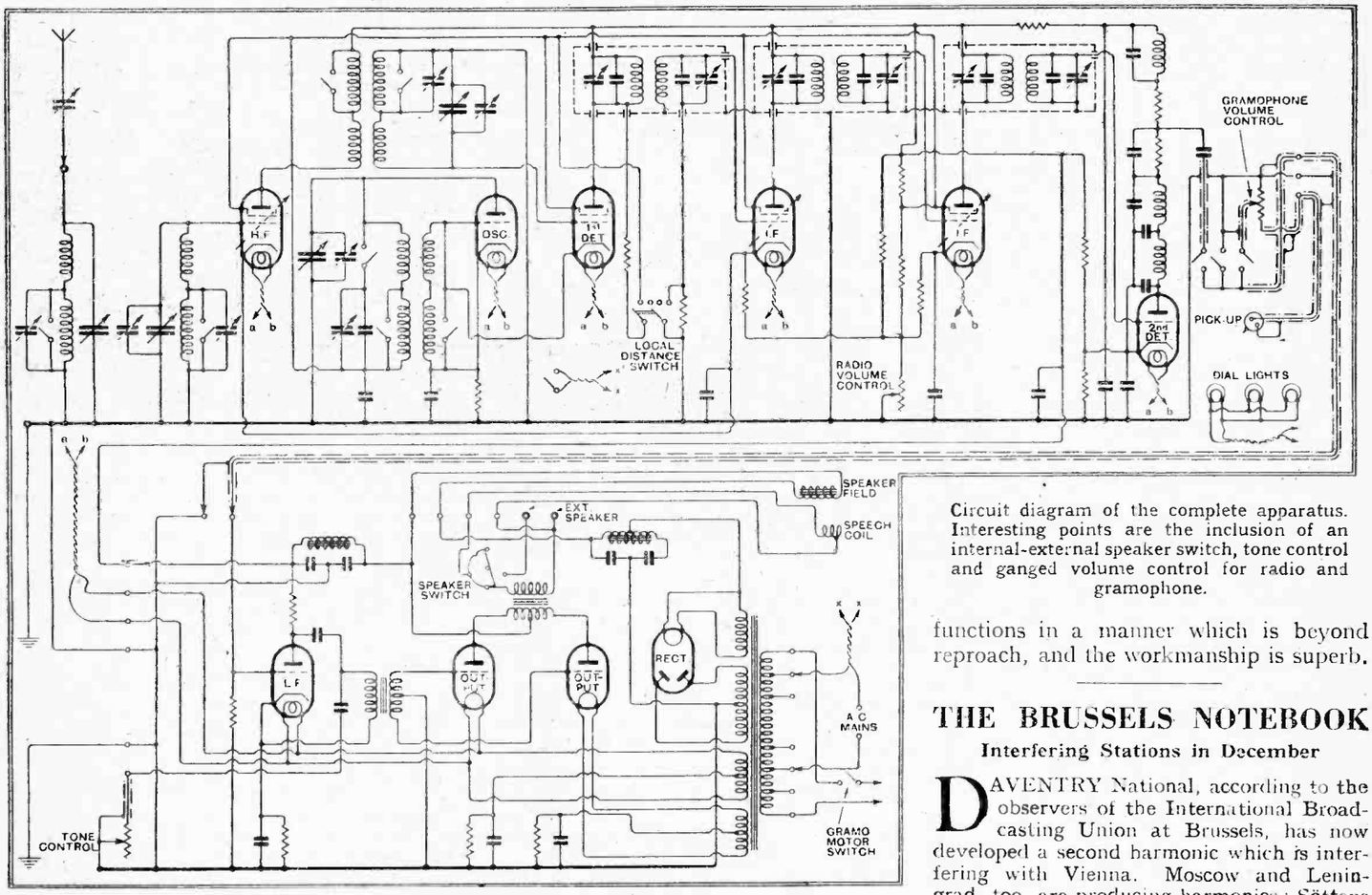
The tuning controls are all mounted on the gramophone board, and the tuning scale is set at a convenient angle. It is calibrated and illuminated by a series of concealed lamps; these lamps are interconnected with the combined wave-range, radio-gramophone, and on-off switch, so that the appropriate scale is illuminated. In addition to these, there are the tone control and the local-distance switch.

At the rear of the set provision is made for the connection of an external loud speaker, and a three-position switch permits this to be used alone or in conjunction with the internal speaker; alternatively, the latter may be used alone. When installing the set, no adjustments are required by the user beyond a single trimmer in the aerial circuit. The care and attention to detail which have been put into the design of this receiver are shown up by the inclusion of a special insulated screwdriver for making this solitary adjustment.

The performance of the set leaves little to be desired, and the quality of reproduction sets a very high standard. The bass is well reproduced, without any trace of box resonance, and quality on gramophone is exceptionally fine. The general tone on radio is slightly lower, but with the local-distance switch set for local reception there is abundant evidence that the higher frequencies are being reproduced. The general effect is of well-balanced tone, and, even at large volume, harmonic distortion is commendably low.

The sensitivity, of course, is adequate for any ordinary purpose, and the set will rarely have to be worked all out. The selectivity, too, is of a very high order, and probably reaches the maximum useful value. Undesired responses are negligible, and the volume control has a wide range, while the waverange switch is now silent in operation.

The walnut cabinet is extremely solid, and its lines are dignified and pleasing. The chassis are of steel and are mounted on absorbent rubber bushes to prevent acoustic feed-back effects. The moving-coil loud speaker is of large dimensions and is provided with a baffle board of acoustically dead material. In fact, in every particular the set shows the care which has been put into its design and construction; electrically, the receiver functions in a manner which is beyond reproach, and the workmanship is superb.



Circuit diagram of the complete apparatus. Interesting points are the inclusion of an internal-external speaker switch, tone control and ganged volume control for radio and gramophone.

THE BRUSSELS NOTEBOOK

Interfering Stations in December

DAVENTRY National, according to the observers of the International Broadcasting Union at Brussels, has now developed a second harmonic which is interfering with Vienna. Moscow and Leningrad, too, are producing harmonics; Söttens and Vienna are also offending, the latter clashing with Frankfurt. Bucharest continues to suffer at the hands of an unknown station.

The medium-wave Leningrad station, RV70, has made its first appearance, and is operating on the same frequency as that of Barcelona, namely, 434.8 metres.

At least one station has "vanished"; this is the Latvia relay at Madona, which has not been heard since December 12th. Nyiregyhaza, one of the new Hungarian relays, seems to be having a wobble competition with Bremen, which is still unable to keep steady. Pecz, the other new Hungarian relay station, has been looking for a wave between 1,420 and 1,445 kcs.

Cardiff is still interfered with by an unknown station, and Radio Vitus continues its St. Vitus' dance around 307 metres.

Telegraphy stations have been interfering on the long waves, particularly around that of Lahti, while an unknown Russian telegraphy station continues to work between Zeesen and Radio Paris, and there is still an interloper within a few kilocycles of 5XX.

Luxembourg has been continuing tests on 252 kilocycles and Vienna on 240 kilocycles. Budapest No. 2 has settled down to 355 kilocycles. Brussels No. 1 is now sharing its wavelength with the Estonian station Tartu, as well as Astrakhan. To complete the tale, Palermo continues to interfere with Munich even on local reception.

BROADCAST BREVITIES

By Our Special Correspondent.

What Does the Diary Say?

SIR JOHN REITH, in an article in *The Wireless World* some twelve months ago, referred to the diary in which he records his personal impressions of the world and affairs. If the diary is still kept—a fairly safe assumption—I can imagine a delightful entry for Tuesday of last week, the day on which Sir John betook himself to the Polish Embassy and laid before His Excellency the Ambassador a note of contrition for the *faux pas* on New Year's Eve.

Retribution

The note, I understand, left certain points to the Polish imagination; for example, it stated that "internal administrative action" had been taken in the matter. One can almost hear the groans of the offender and the clank of the chains.

Another Offender

It may console Sir John Reith to reflect that his is not the only broadcasting organisation to invoke the Polish wrath. A Berlin friend tells me that the Königsberg station has just had a sharp rap over the knuckles by the Polish Ambassador in Berlin for remarks passed about the "Polish Corridor" during a programme on December 28th.

Co-opting M.P.s

The Polish affair has, of course, raised anew the question of whether the B.B.C. should come under direct Parliamentary control. From what I can gather, however, no one really wants such a state of affairs. Personally, I shrink from the idea; the mere notion of members of Parliament contributing more than they do at present to the gaiety of nations suggests sweated industry.

Sad Sequel

Not that the B.B.C. itself has fought shy of the idea. On September 26th last the Corporation with the approval of the Prime Minister courteously invited "the co-operation of a small Parliamentary committee composed of members of both Houses, for the purpose of advising the Corporation on matters connected with political talks."

Alas, no one accepted the invitation!

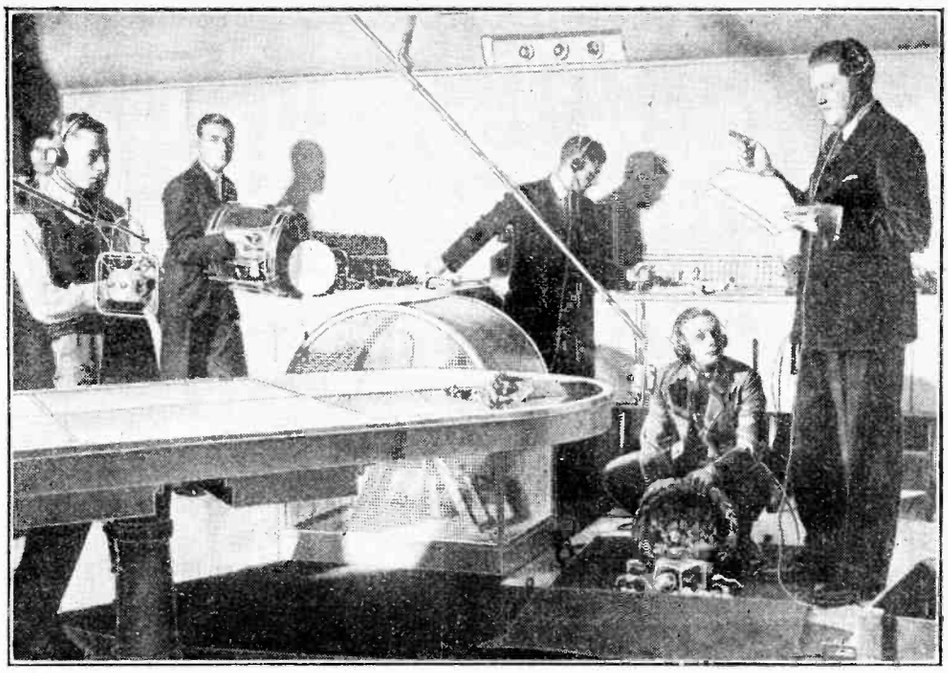
Prospecting in Belfast

BELFAST readers should look out for the B.B.C. mobile transmitter which, I am credibly informed, will soon be exploring the neighbourhood in search of a suitable site for the new high-power transmitter.

The B.B.C. are likely to be attracted by the Divis Hill, which overlooks the city from the west, but they have no special preferences at the moment.

The End in Sight?

The Belfast and Droitwich transmitters may quite possibly be ready at the same time, i.e., the end of next year. The Regional and Long-wave Broadcasting Schemes will then be complete, unless the B.B.C. ventures on a new northerly station on the long-wave band.



NOISE-MAKING AS A PROFESSION. A photograph taken recently in the "effects" department at Broadcasting House during the performance of a radio drama. The man on the left is producing the impression of splintering wood by crushing a match-box close to the microphone. A drum held against a revolving disc simulates an aeroplane propeller, while rushing wind is suggested by the wind machine in the cage. Falling buildings are also represented.

I understand that although the order has been placed for the new "series modulation" transmitter at Droitwich, work may not be started there for some time.

An Awkward Clause

AN unusual dilemma has confronted the B.B.C. in regard to the new headquarters at Leeds. Some perspicacious individual discovered a clause in the deeds of the building to the effect that it must never be used as a place of entertainment, the explanation being that the future broadcasting headquarters is a converted Friends Meeting House.

Happily, the lawyers have pointed out that all will be well if no charge is made for admission! So the new Broadcasting House will open in a few weeks' time.

How We Help

EVERY British wireless licence holder can now clap his hand to his heart and say: "I help to cheer the Empire and especially South Africa!" For while the Empire programmes (paid for by British listeners) are floating on the four winds of heaven, South Africa now has the special privilege of picking them up and relaying them from Cape Town and Johannesburg without giving prior notice to the B.B.C.

Reciprocal Programmes?

In time, no doubt, the other Dominions and Colonies will follow suit, and perhaps the day will come when they will reciprocate. A sound picture or running commentary dealing with gold mining in the Rand would cheer us not a little.

Cyril Maude to Broadcast

WHEN that classic among comedies in the English language, "The School for Scandal," is broadcast on January 23rd and 24th, the part of Sir Peter Teazle will be played by the well-known actor Cyril Maude. The late William Archer, one of the most eminent critics of all time, described Mr. Maude's Sir Peter, when the play was produced at the Haymarket many years ago, as the best he had even seen.

Left-handed Quartet Leader

ONE of the several quartets who will broadcast during the Chamber Concert season in the Concert Hall, Broadcasting House, is the Kolisch. They will arrive in England next month and are to play every day for a fortnight, the dates of their broadcasts being February 13th and 25th. The leader of the Kolisch Quartet is left-handed—the result of an accident in childhood.

Hotter and Hotter

HENRY HALL is getting hotter and hotter. Who would have guessed twelve months ago that the modest conductor of the Gleneagles Hotel dance combination would have the first call in this country on the hot jazz numbers of Duke Ellington and Louis Armstrong?

The contract has just been signed with these, the two hottest of America's jazz monarchs.

Say It with Dancing

By the way, Henry Hall has received some really enthusiastic tributes from the Continent—Germany especially—as a result of the recent European relays by the B.B.C. Dance Band. A German youth of 17 to whose letter of appreciation Henry Hall sent a reply has responded with the noble remark: "Englishmen are gentlemen."

Another Feat

I must also chronicle the fact that the B.B.C.'s Dance Band conductor has earned the distinction of being the first man to smash a microphone beyond repair. It happened a few days ago when he was showing Irving Berlin around Broadcasting House. They had reached the Television studio in the basement when Henry, dazzled by the glare from one of the Baird "searchlights," collided with a microphone stand. If the stand had been stronger . . . .

LABORATORY TESTS

NEW RADIO PRODUCTS REVIEWED

CLIX INSULATED SOCKET

THE latest type of insulated socket developed by Lectro Linx, Ltd., 254, Vauxhall Bridge Road, S.W.1, for mounting on metal chassis is now provided with a small terminal in place of the usual soldering tag. It is felt that this will appeal to those home constructors who prefer the nut and screw method of connection to soldering, especially on small parts that could be damaged unless special care is exercised when using the soldering iron.

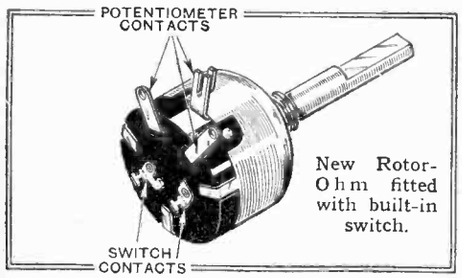
Clix new insulated socket fitted with a small screw terminal.

The new socket, which costs 2½d., can be used either with a solid plug or with one of the divided prong type, such as the Clix master plug. It is made in two colours, namely, red and black, and is available with the usual range of markings.

ROTOR-OHM VOLUME CONTROL WITH SWITCH

ROTOR ELECTRIC, LTD., Spencer House, South Place, Moorgate, London, E.C.2, are now manufacturing wire-wound Rotor-Ohms in this country, production being well in hand of all values up to 50,000 ohms. All models can be supplied with or without a switch, and provision is now made for ganging. Thus the new models meet every present-day requirement, but they possess the added advantage of compactness, for the specimen tested, which is fitted with a switch, measures only 1½in. in diameter and 1in. deep. The switch is embodied in the design and is not an appendage.

The resistance element is mounted so that the contact arm reaches the end of the track before the switch lever is moved, and there is then no further change in the resistance during the final rotation of the spindle.



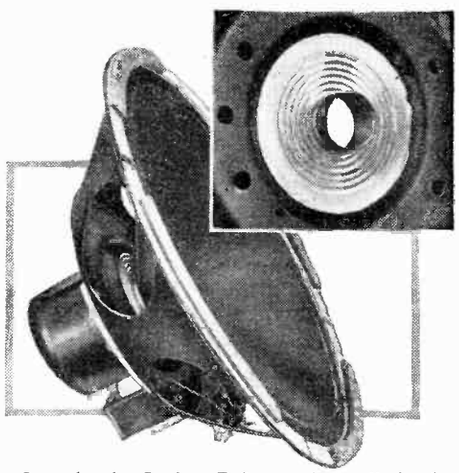
New Rotor-Ohm fitted with built-in switch.

The price is 3s. 6d. each up to 25,000 ohms and 4s. each for all values up to 50,000 ohms. If fitted with a switch the price is raised by 1s. in all cases, while provision for ganging costs an additional 9d.

SONOCHORDE LOUD SPEAKERS

FROM the point of view of mechanical design probably the most interesting feature of the Sonochorde loud speakers is the method of centring the moving coil. Instead of the customary radial spider, a concentrically corrugated disc is employed which gives enormous lateral rigidity without appreciably affecting the normal movement of the speech coil. Examination reveals that the periphery of the one-piece diaphragm does, in fact, provide a greater control than the sub-diaphragm. There can be no doubt that this form of construction gives greater immunity from damage and is conducive to permanence of the response characteristic.

Three models were submitted for test—the Standard P.M. and D.C. and the Senior D.C. The first two are fitted with 7in. diaphragms, and the performance as regards frequency response is similar, though, as might be expected, the sensitivity of the mains-energised model is the better of the two. The bass resonance occurs at about 110 cycles, and the lower cut-off is at about 75 cycles. The magnitude of the bass resonance is just sufficient to give adequate body to music without introducing colouration to speech. Ascending the frequency scale, there is a shallow trough in the region of 250-350 cycles, after which the output regains the normal level and maintains it up to 2,000 cycles. Following a resonance between 2,500 and 3,000 cycles, the output continues to 8,000 cycles at a level which is much higher than the average.



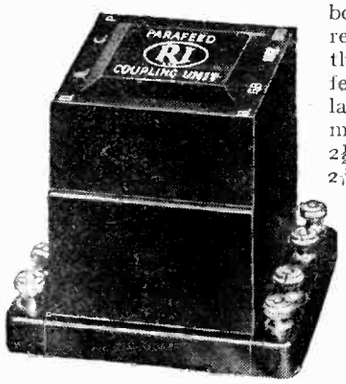
Sonochorde Senior D.C. moving-coil loud speaker and (inset) enlarged view of corrugated centring diaphragm.

The Senior D.C. model, which is fitted with an 11in. cone, is in every way a first-class reproducer. The bass response is full down to 60 cycles, and a careful exploration failed to reveal any prominent resonances in the response up to 7,000 cycles, which marks the commencement of the high-frequency cut-off. Further, from the point of view of efficiency and sensitivity this model is equal to anything we have so far tested, regardless of price.

All Sonochorde models are provided with output transformers with alternative ratios for low impedance power valves or pentodes. The makers are Sonochorde Reproducers, Ltd., 1, Willesden Lane, London, N.W.6, and the prices of the models tested are as follows: Standard D.C., 25s.; Standard P.M., 32s. 6d.; Senior D.C., 42s. 6d.

PARAFEED COUPLING UNIT

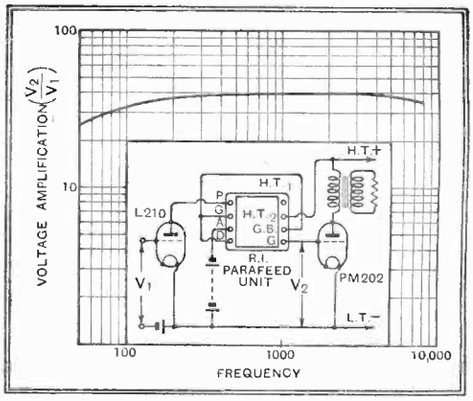
THE Parafeed L.F. transformer which was introduced in the spring of 1931, having been designed especially for use with the parallel-feed L.F. coupling system, required the addition of a resistance and a condenser to complete the coupling link. Radio Instruments, Ltd., Purley Way, Croydon, Surrey, have now embodied the three essential components in one compact unit, which, in addition to considerably cheapening the cost of the complete coupling, has led to a marked reduction in the total baseboard space required, for the new Parafeed unit in its latest form measures but 2½in. × 2½in. × 2 3/16in. high.



R.I. Parafeed coupling unit.

The internal resistance and condenser are completely isolated from the transformer, so that all the advantages of the original Parafeed transformer are retained, and the unit can be connected to give transformer ratios of 1:2, 1:3 or 1:4, in addition to various other arrangements. The instructional leaflet shows ten different combinations, including one push-pull amplification, but for this purpose an additional Parafeed transformer is required. The resistance included in the unit is provided with a tapping, so that a part of it can be used for decoupling the anode circuit if required.

For the purpose of our tests the unit was connected to give a 1:4 step-up ratio; two-volt battery valves were used, and the whole of the resistance included in the anode circuit of the first stage. Over the major part of the frequency range an amplification of forty times was obtained. Although there is a slight falling off in voltage amplification below 100 cycles, it will not have a noticeable effect on the reproduction, as the acoustic output will be sufficient to preserve a satisfactory balance. Indeed, the response at 100 cycles is only 1.5 decibels below that at 1,000 cycles, while even at 50 cycles the reduction is not more than 4 decibels.



Frequency-amplification curve of R.I. Parafeed coupling unit.

The unit is mounted in a neat moulded bakelite case, having an internal metal screen, and provision is made for earthing this *via* the fixing screws. The price of the coupling unit is 11s. 9d.

UNBIASED

A Tale of a Tick

I HAVE just paid a second visit to the two listening halls in Broadcasting House which I mentioned a week or two ago. My object was to enjoy a peaceful musical evening of the kind which has been practically impossible at home during the past few days owing to an avalanche of aunts and sisters-in-law who have descended on my humble abode and at present show no sign of moving.

I made myself comfortable in one of the armchairs provided by the thoughtful B.B.C. and closed my eyes, partly to increase my enjoyment of the music and partly to veil from sight the hideous futuristic-looking furniture. I had not been listening long, however, when I became conscious of irritation. In spite of all my efforts to concentrate, my enjoyment was quite spoilt by the distracting click of the wretched electric slave clock which ticked every half-minute. Since its wiring was buried in the wall, I was completely baffled in attempts to

One man's meat . . .

disconnect it. As it was, I found I could stand the noise no longer, and was compelled to leave the building in a thoroughly disgruntled mood.

I don't think I have met a clock of this type with a louder or more exasperating click, but the really nerve-racking part was waiting for it. Surely somebody has blundered very badly in not foreseeing this trouble, for here, if anywhere, the use of a tickless clock is justified. I am not, of course, referring to electrical interference produced in the loud speaker, for the clock was quite silent in this respect.

Psychological Moments

THERE seems to be no end to the practical applications of the principles of radio. The latest is intended to lessen the terrors which the dental chair has for children and even adults. A despoiler of good teeth with whom I am acquainted is the individual who has devised this latest adjunct to his fee-snatching business. His first experiment was to provide his juvenile victims with a pair of headphones connected up to a wireless set, but he speedily found that such items as fat-stock prices and talks on psycho-analysis failed to hold the

By

FREE GRID

children's attention against the counter-irritation provided by drills and forceps.

He has now solved the problem in a very ingenious manner. The headphones are connected to a gramophone pick-up in an adjoining room wherein sits a psychological expert with a peephole through which he is able to observe the patient. According to his judgment of the child's psychological make-up, the expert switches on different types of gramophone record and even, in desperate cases, introduces a microphone and puts over a "bed-time" story himself. My friend is now extending the system to his adult patients, but his tame psychologist is finding the task of selecting suitable items much more difficult, and has found out the fundamental truth of the old saying that what is one man's meat is another man's poison.

Surely this idea gives a golden opportunity to the B.B.C. for making their audition tests really helpful. All they have to do is to put would-be comedians in front of the dentist's microphone and watch the effect on the victims. If any aspirants to studio honours could get a laugh out of a man in the execution chair he would be good enough for a long contract with the B.B.C. Similarly, loud speakers might be erected at the receipt of custom in a Scottish income-tax collector's office; the raising of a laugh from

. . . is another man's poison.

a thrifty Scot when paying over the bawbees would surely be the hall-mark of the born comedian.

A Mystery Box

MY attention was arrested the other day by an article in a foreign wireless journal giving "full technical details of the system employed by the British Post Office engineers to detect unlicensed receivers." Naturally, I seized upon the opportunity of improving my knowledge upon this matter, losing no time in arming myself with a ponderous dictionary and commencing the painful work of translation. I was bitterly disappointed, however, to find that at the end of my labours I was no nearer the truth than before.

After giving a very ordinary description of a sensitive multi-valve receiver employing a frame aerial, the article finished up by stating that everything really depended upon a secret device housed in

Could assist the Post Office authorities.

a steel cylinder. It further explained that this device made use of "an entirely new principle of radio."

The most remarkable thing about the whole report, however, was a statement at the end to the effect that these secret devices, all ready to connect up, would shortly be supplied to all licence holders in England so that they could assist the Post Office authorities in tracking down unlicensed listeners. To crown all, it was alleged that the instrument would be supplied to each licence holder in a sealed box so that he would be unable to wrest from it the marvellous "secret circuit."

Criticism of Hospitals

AS the result of my recent note regarding hospital sets I regret to say that my post-bag has been filled with moans from patients and ex-patients.

Complaints are not confined to small provincial hospitals, nor yet to the larger ones, but come even from some of the greatest of the metropolitan establishments which I thought were above suspicion. In practically every case the barbarous practice of switching off at a ridiculously early hour of the evening is in vogue, the hospital authorities being so much beyond the æsthetic pale that they cut the set off even in the middle of a musical item.

As for man-made static, this appears to be intolerable, although caused in many cases—and this is the ludicrous part of it—by electrical apparatus under the control of the hospital authorities themselves! Lifts, X-ray apparatus, and therapeutic apparatus, generally, are particular offenders.

The Valve Filament

Part II.—The Coating and the Part it Plays

By R. T. BEATTY, M.A., B.E., D.Sc.

IN the previous instalment it was pointed out that in a cold filament the electrons dash about with an average speed of 58 miles per second but that at this speed they could only pass across a retarding potential difference of 1/40th of a volt, while in order to escape from the surface they must surmount a barrier of 4.5 volts.

Table A gives the average speed corresponding to certain temperatures and also the voltage barrier which can be overcome, and it appears that in a filament at 15 deg. C. only those electrons which have $791/58 = 14$ times the average speed can escape from the surface.

Now and again an electron *does* attain this critical speed. There is a remote chance that a number of lucky collisions may boost it to 14 times the average speed, but the fantastic slenderness of the chance is shown by the curve of Fig. 3, which has been worked out from the well-known laws of probability.

The vertical scale gives the chance that an electron should have a speed in excess of the figure given by the horizontal scale, and the diagram may be regarded as a ladder in which each rung represents a chance of a millionth of that at the rung immediately above. The top rung is the chance that the speed should exceed zero, and is, of course, a certainty. At the next rung below, corresponding to speeds exceeding 3.8 times the average value, the chance is one in a million (10^{-6}), while for speeds exceeding 5.5 times the average the chance is one in a million million (10^{-1}), and so on, till at 14 times the average speed the chance falls to 10^{-72}. To write this at full length we should put down a decimal point, follow it with 71 zeros, and finish off with the figure "one."

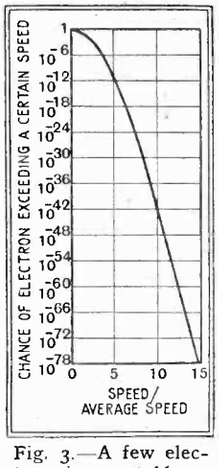


Fig. 3.—A few electrons in a metal have 5 or 10 times the average speed: the curve shows how very small is the chance that this should occur

As illustrations of the extreme improbability represented by this figure we may say that it is the chance that heads should turn up 240 times running, or that a man should predict correctly the order of finishing of a field of 54 horses in the Grand National, or that the purchaser of 11 tickets out of 4 million sold in a sweepstake should draw the first 11 prizes. To put it shortly, *unaided escape of an electron from a cold filament is impossible.*

But suppose the filament raised to a white heat. The table shows that the average speed of an electron is now 166 miles per second, and any electron which has 4.76 times this speed attains the critical speed of 791 miles per second, which enables it to emerge. Fig. 3 shows that the chance of exceeding this speed is 10^{-10} or one in ten thousand million, and, though this is a poor chance for any single electron, we must remember that a cubic millimetre of tungsten contains 10^{20} free electrons, so that 10^{10} of these are capable of escape if they happen to lie close to the surface. It is from this small high-speed fraction of the total population of electrons that we obtain the filament emission required to operate a valve.

LONG before the days of broadcasting it was found that if a small piece of sealing wax were fused to a platinum filament in a soft valve a copious flow of electrons could be detected. Year after year this device has been developed until to-day we have the coated filament which emits its electrons at such a low temperature that we are constrained to ask "How far off is the cold valve?"

Life of 1,000 hours

The emission in amps. per square centimetre of a tungsten filament at various temperatures is shown by the right-hand curve of Fig. 4. At 2,100 deg. C., the temperature at which a filament is usually operated, the emission amounts to about 0.1 amp. per sq. cm. of surface, and this temperature is so far below the melting point (3,270 deg. C.) that a life of a thousand hours is usual before the filament fails owing to volatilisation of the metal.

No other pure metal is as emissive as tungsten, for no other metal can be kept at such a high temperature without rapid wasting due to volatilisation. But in 1914 it was accidentally discovered that a small percentage of thorium, which exists as an impurity in tungsten ores, enhances the emission considerably. The thorium atoms diffuse outwards to the surface of the hot filament, where they form a layer one atom in thickness, and, although this layer keeps on evaporating, it is replaced by the outwardly diffusing atoms which underlie it and can be maintained for a thousand hours of use. The effect of this layer is to reduce the potential barrier at the surface from 4.5 volts (its value for tungsten) to 3.15 volts, with the result that the emission would increase a thousandfold if the temperature were maintained at 2,100 deg. C. Actually the thoriated filament is only heated to 1,600 deg. C. to prevent undue evaporation of thorium, and, as Fig. 4 shows, the emision is 10 times that of pure tungsten when each filament is kept at its correct temperature.

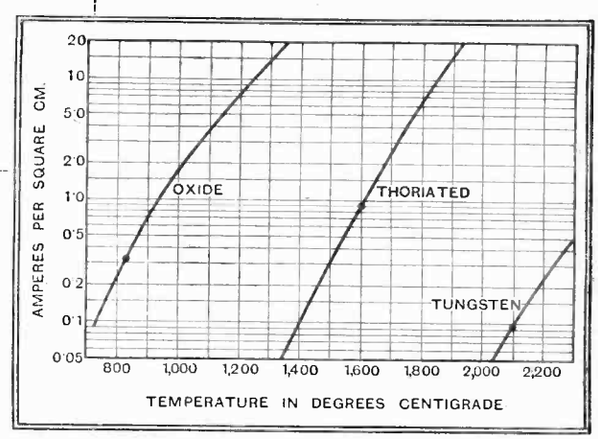


Fig. 4.—The emission from three types of filament plotted against temperature. The dots indicate the usual operating temperatures.

The comparison between the two types of filament is most simply made on a basis of emission per watt of heating power drawn from the L.T. battery. For tungsten the figure is 2 milliamps. per watt, and for thoriated tungsten 40 milliamps. per watt; so that, for equal emissions, the latter filament requires only 1/20th as much battery current. The advent of this filament made it possible for the first time to use dry cells for L.T. supply.

Considerable liberties can be taken with thoriated filaments, for if the thin layer of thorium is completely volatilised due to excessive heating, as when, for example, the H.T. battery is accidentally applied for a moment to the filament terminals, it is only necessary to run the filament a little above its usual temperature for about an

TABLE A.

Temperature in degrees Centigrade.	Speed in miles/sec.	Volts.
15 (ordinary temp.)	58	0.0243
2,100 (white heat)	166	0.200
47,500 (hottest known star)	791	4.52

The Valve Filament—

hour (with the H.T. reduced to about quarter-value), whereupon a new layer will diffuse to the surface and the emission will be as good as ever.

But the thoriated filament is now, in its turn, heading for limbo in face of the powerful competition of the coated filament. Long before the days of broadcasting it was known that a speck of sealing wax burnt on to a platinum filament gave rise to a stream of electrons so dense that, in a soft valve containing a trace of air, a luminous streak could be seen. This primitive device has been gradually developed into its modern form in which a core of tungsten wire is provided with a nickel covering to give a surface to which the oxide coating adheres strongly; the oxides of barium and strontium are then deposited on the nickel, and by glowing the filament a thin layer of barium and strontium separates out on the surface, as shown in Fig. 5.

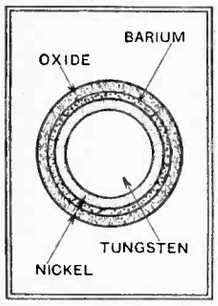


Fig. 5.—Cross-section of coated filament. A nickelled-tungsten wire carries a thin layer of metallic barium reduced from barium oxide.

The presence of this layer reduces the potential barrier to one volt, and, consequently, the electron emission is enormously increased (Fig. 4, left-hand curve) so that the operating temperature can be reduced to 830 deg. C.—a barely visible dull red glow. The emission efficiency is 100 milliamps. per watt, so that in a 2-volt filament one-fifth of the filament current actually escapes as electronic emission.

Indirectly Heated Cathode

The great efficiency of coated filaments has made it possible to employ indirect heating by making the emitting surface or cathode in the form of an oxide-coated cylinder entirely disconnected from and enveloping the heating wire; sufficient emission is obtained when 4 watts are consumed by the heater, whereas with a pure tungsten cathode 200 watts would be called for on account of the much higher temperature required, and a receiving valve of ordinary dimensions would be quite unable to dissipate this power without serious overheating. Another advantage of low-temperature cathodes is that the distortion on heating is so slight that the grid can be brought very close, with consequent greater controlling power, as in the "Micromesh" output valve, where a change of 1 volt on the grid changes the plate current by 12 mA.

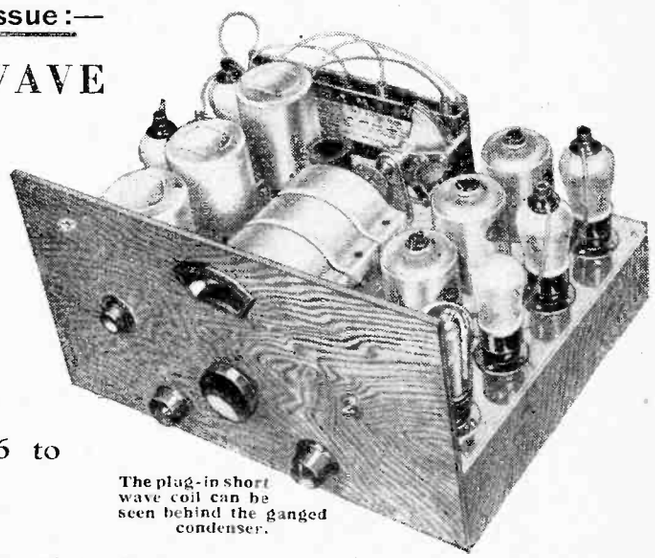
We have seen that progress in filament construction has been largely due to methods of diminishing the magnitude of the voltage barrier which exists at the surface of all conductors. Already with coated filaments one-fifth of the current from the L.T. battery escapes from the surface, and it may be that science will discover how to lower the barrier still further. After all, if the barrier could be reduced to half a volt the emission from a cold filament would be as great as we now get from a hot one, and L.T. batteries would become superfluous. So that we should not despair of the eventual appearance of the cold valve.

It is sometimes suggested that since electrons are emitted from alkali metal surfaces under the influence of light we might design a valve to work with a cold cathode sensitive to light. At present, however, it is much more economical to heat the filament directly than to use power to operate the source of light. In fact, if all the light from a lamp of one candle-power is concentrated on the cathode of the most sensitive photo-cell known the emission is ½ milliamp., and since ½ watt is required to operate the lamp the efficiency is only 1 milliamp. per watt, as against the much higher emission of the coated filament.

In Next Week's Issue:—

The ALL-WAVE MONODIAL SUPER

A Highly Sensitive and Selective Battery Superheterodyne. Tuning from 12.26 to 2,000 Metres



The plug-in short wave coil can be seen behind the ganged condenser.

A SINGLE-CONTROL superheterodyne covering the range of 12.26-98 metres, in addition to the two normal broadcast bands. Built-in coils with waveband switching are provided for the latter two, and another switch permits any one of the four short-wave bands to be selected at will. Single-dial tuning is operative on all wavelengths, and an unusually high degree of adjacent channel selectivity is maintained on the shortest wavelength. In spite of, or rather because of, the use of seven valves, the current drain upon the H.T. battery is unusually low and totals no more than 13 mA. at 100 volts. The quality of reproduction reaches a high standard, and the sensitivity is adequate for the reception of the weakest stations under even poor conditions.

LIST OF PARTS REQUIRED

After the particular make of component used in the original model, suitable alternative products are given in some instances

1 **Three-gang Superhet condenser,** 0.0005 mfd. — Polar "Star"

1 **Short-wave variable condenser,** 0.00016 mfd. — Eddystone No. 922

1 **Slow-motion dial** — Eddystone No. 933

1 **Insulated coupling** (Ormond) — Cyldon

1 **Compression type condenser,** 0.002 mfd. (Formo, R.I.) — Polar "Preset"

1 **Set of Superhet coils** — Telsen

1 **Set of short-wave coils** comprising 1 L.B., 1 Y, 1 R, and 1 2BB — Eddystone No. 932

3 **I.F. transformers,** 110 k.c. (Colvern, Wearite) — Varley BP21

1 **H.F. choke** — Eddystone No. 505

1 **Screened H.F. choke,** Superhet type (Wearite) — Bulgin H.F.10

1 **Special switch assembly** — Wearite

1 **Single-pole switch Q.M.B.** (Claude Lyons) — Bulgin S.80

1 **Two-pole switch Q.M.B.** (Claude Lyons) — Bulgin S.88

1 **Potentiometer,** 25,000 ohms (Colvern, Watmel) — Igranic No. 2235/7

1 **Resistance,** 100 ohms, 1 watt — Claude Lyons

1 **Resistance,** 1,000 ohms, 1 watt — Claude Lyons

1 **Resistance,** 2,000 ohms, 1 watt — Claude Lyons

2 **Resistances,** 5,000 ohms, 1 watt — Claude Lyons

1 **Resistance,** 10,000 ohms, 1 watt — Claude Lyons

1 **Resistance,** 25,000 ohms, 1 watt — Claude Lyons

1 **Resistance,** 250,000 ohms, 1 watt (Dubilier, Erie) — Claude Lyons

1 **Fixed condenser,** 0.01 mfd. mica — T.C.C. No. 34

3 **Fixed condensers,** 0.001 mfd. mica — T.C.C. No. 34

1 **Fixed condenser,** 0.001 mfd. mica — T.C.C. type "M"

2 **Fixed condensers,** 0.0001 mfd. mica — T.C.C. No. 34

7 **Fixed condensers,** 0.1 mfd. non-inductive 400 v. D.C. test — T.C.C. No. 50

2 **Fixed condensers,** 1 mfd. non-inductive 400 v. D.C. test — T.C.C. No. 50

1 **Fixed condenser,** 2 mfds. non-inductive 400 v. D.C. test (Dubilier, Telsen) — T.C.C. No. 50

1 **Coupling unit** (Benjamin, Bulgin) — R.I. "Parafeed"

8 **Valve holders,** 5-pin (British Radiophone, Bulgin, Burton, Eddystone, W.B.) — Clix, chassis-mounting type

1 **Battery cable,** 5-way, 30in., with wander plugs marked GB+, GB—1, GB—2, GB—3, GB—4. (Bulgin, Concord, Goltone, Harbros, Lewcos) — Belling-Lee

1 **Battery cable,** 5-way, 54in., with spade ends marked LT+, LT— and wander plugs marked HT— HT+1, HT+2 (Bulgin, Concord, Goltone, Harbros, Lewcos) — Belling-Lee

1 **Connector,** 5-way — Wilburn

1 **Grid-bias battery,** 16½ volts

1 pair **G.B. battery clips** (Bulgin, Burton, Ormond) — Cripso

4 **Ebonite shrouded terminals,** aerial, earth, LS+, LS— (Belling-Lee, Burton, Clix, Eelex) — Igranic "Indigraph"

2 lengths **Screened sleeving** (Concord, Harbros, Lewcos) — Goltone

Plymax baseboard, 12in. x 16in. x ⅜in. — Peto-Scott

Panel, oak-faced ply, 9in. x 16in. — Peto-Scott

Plywood, ⅜in., 12 length Systoflex, 2ozs. No. 20 tinned copper wire, etc.

Wood screws, 30 ⅜in. No. 4 R/hd., 14 ½in. No. 4 R/hd., 19 ¼in. No. 4 R/hd., 22 ⅜in. No. 4 R/hd., 6 1¼in. No. 4 C/sk.

Metal screws, 4 ½in. No. 4 B.A. with nuts and washers, 5 ½in. No. 5 B.A. with nuts and washers.

1 **H.T. battery,** 105 volts — Ever Ready Popular Power type

Valves, 3 Cossor 220 VSG or Marconi or Osram VS2, 1 Cossor 215 SG or Marconi or Osram S21, 2 Cossor 210 HF or Marconi or Osram HL2, 1 Mazda Pen. 220A.

READERS' PROBLEMS

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.
Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

A Defective Oscillator Coil?

AFTER having carried out a preliminary test, a reader has come to the conclusion that the oscillator coil of his "Baby Superhet" has become defective, and asks whether a more conclusive test can be made with the help of a voltmeter.

Properly applied, a high-resistance voltmeter should give a practically certain indication as to whether everything is in order. The meter should be joined between the chassis and terminal No. 6 of the oscillator coil; the negative terminal of the meter being, of course, connected to the metal work. A short-circuit should then be made between terminals Nos. 4 and 6, when a reading of some 25 volts should be shown, the exact voltage depending upon the voltmeter resistance. With the short-circuit removed, a slight fall in voltage should take place. The tuning condenser should then be rotated, and if at any point within the tuning range the voltage falls to zero, or even reverses its polarity, a definite fault is indicated. It is just possible that this fault might be in the combined detector-oscillator valve, or in the voltage supply to its priming grid, and not in the coil.

Bias-limiting Resistance

IT would appear that the purpose of the resistor R5 in the "Straight Three" (*The Wireless World*, December 16th, 1932) is not clear to a number of readers. The resistor in question is connected in series with the volume-control potentiometer.

This component may best be described as a "bias limiter"; its purpose is to avoid the possibility of operating the H.F. valve with a zero grid, even with the control potentiometer slider at the "maximum" position. By observing this precaution anode current is conserved, and the risk of selectivity being impaired by the flow of grid current is avoided.

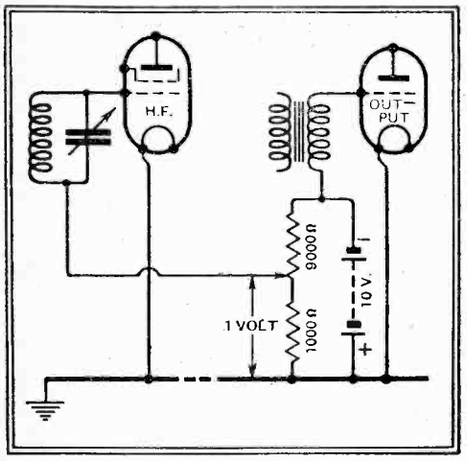


Fig. 1.—Explaining the function of a bias-limiting resistance. A similar result might be brought about by restricting mechanically the rotation of the potentiometer slider.

The functioning of the resistance will be made clear by the simplified circuit diagram given in Fig. 1, where arbitrary values are used in order better to illustrate the point at issue.

Assuming that a potentiometer of 9,000 ohms and a fixed resistor of 1,000 ohms be connected in series across a 10-volt bias battery the voltage developed across the first component will amount to 9 volts, and across the second to 1 volt. Taking these values, grid bias for the H.F. valve may be varied between 1 volt negative and 10 volts negative by rotation of the potentiometer slider. Due to the interposition of the 1,000-ohm fixed resistance the grid cannot be operated with a less negative bias than 1 volt, which, in practice, will be about right.

From this explanation it will be fairly evident that the relative values of limiting resistance and potentiometer are determined by simple proportion; a fixed resistance and potentiometer of respectively 10,000 ohms and 90,000 ohms might be used, for example, in place of the values given.

Voltage Measurements with a Milliammeter.

A READER who has just constructed a high-power A.C. set wishes to check the various anode voltages of his receiver. Maximum voltage is in the order of 400 volts, and the only measuring instrument in his possession is a multi-range milliammeter of which the lowest scale reading is 0.5 milliamps.

A voltmeter is, after all, nothing but a milliammeter fitted with a suitable value of series resistance, and then calibrated in volts. Our querist should be able to obtain voltage readings which are accurate enough for most practical purposes by using his milliammeter (on the lowest range) in series with a suitable resistance. Ignoring the internal resistance of the instrument, which we may legitimately do, a value of 100,000 ohms will do well, and the meter will then measure voltages up to 500. By multiplying the reading in milliamps by 100, the dial indications may be readily converted into voltages; 2 milliamps will correspond to 200 volts, 3 milliamps to 300 volts, and so on.

We should not conclude this reply without the usual warning that, as always, voltage readings will be reasonably accurate only when the value of the external series resistance is low compared with that of the meter resistance. For example, it is not possible by ordinary means to measure the precise voltage applied through a potentiometer to an H.F. valve screening grid.

The Wireless World INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block-letters at the top of all communications.

Whistle Suppression and Push-pull

ALTHOUGH the Whistle Suppressor (*The Wireless World*, October 28th, 1932) will in most cases work most satisfactorily when connected across an L.F. intervalve coupling device, it is often much more convenient to apply it to the output circuit—loud speaker or output transformer, etc.

To a reader who wishes to add the Whistle Suppressor to a set with push-pull amplification, and who is unwilling to disturb internal wiring, we suggest that the terminals of the suppressor should be joined between the anodes of the output valves, as shown in Fig. 2. This will probably be found satisfactory, but another reader who

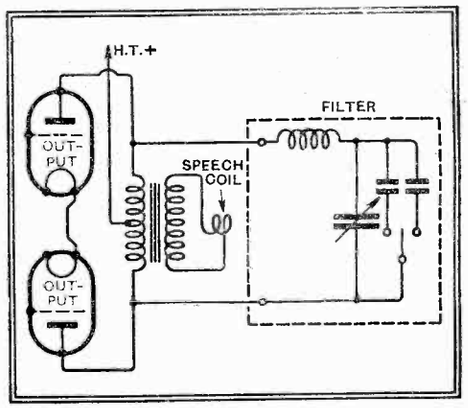


Fig. 2.—The Whistle Suppressor connected across a push-pull output transformer.

uses pentodes in push-pull, with tone compensation in the output circuit, will probably find that this plan is unworkable. This is because the impedance of the output circuit, at high frequencies, will be seriously reduced by the presence of the corrector.

The Wrong Beat

MOST users of superheterodyne receivers are aware that a given station can be received at two distinct settings of the oscillator tuning condenser, but since ganged tuning control has become almost universal, this fact does not usually become evident. As a rule, when initial adjustments of modern sets are made in the manner advocated, there is little risk of working on the wrong beat; with a ganged superheterodyne, it is always intended that the higher of the two beats (in terms of frequency) should be employed.

A correspondent who has built the "Baby Super" has noticed a somewhat serious falling off in sensitivity at the lower end of the wavelength scale, and goes on to describe symptoms which lead us to suspect that the circuits are adjusted in such a way that the wrong beat is being employed. An indication that this is happening is often afforded by the fact that the trimmer of the oscillator circuit is set at nearly full capacity; normally its control should be almost fully unscrewed.

To make sure, we advise that our reader should make another adjustment of ganging at about 300 metres, on which wavelength it is almost impossible to set the oscillator for the wrong beat. The next step would be to make a further rough ganging adjustment at about 250 metres, and finally to set all the trimmers at a still lower wavelength.

The Wireless World

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CONTENTS

EDITORIAL COMMENT

Foreign Station Listening

A "Huge Misunderstanding"?

IN a letter contributed to the Correspondence columns of this issue a reader makes the suggestion that there exists "a huge misunderstanding in receiver design." Our correspondent proceeds in his letter to explain this statement and makes a number of observations which cannot fail, we think, to interest our readers and to promote discussion, for the reason that many of the statements or implications contained in the letter are highly controversial.

The main burden of the letter is the suggestion that the public are prepared to pay the price of a selective long-distance receiver but that, in point of fact, this receiver is not likely to be used for serious listening on any but the local home station, except for a few spasmodic twirls of the dial indulged in occasionally for the satisfaction of demonstrating the capabilities of the set. It is suggested, further, that designers and manufacturers are devoting untold efforts towards satisfying the public demand for a set with maximum capabilities, whereas, in point of fact, there is no genuine demand on the part of the public for any such performance.

If these suggestions in favour of listening exclusively to the local station had been put forward a year or two ago they would, we think, have been received more sympathetically, but for such an attack to be launched now, at a time when the transmissions from abroad have gained so much in reliability, strength and quality of programmes, will come as a complete surprise to many readers, more especially to those many listeners who regard overseas stations as their local transmitters.

We shall, no doubt, be represented as taking sides in this controversy. But a little bias in favour of alternative programmes to listen to must be excused us, for the reason that we have already shown our belief in the interest of the public in these transmissions by including details of the foreign programmes week by week. In this step which we have taken we already have ample evidence to refute any suggestions that foreign listening is not popular, but then the contributor to our Correspondence columns appears to be openly arguing that we are all mad and that it is time we awoke to a realisation of the fact! Let us hear what other readers have to say about this "huge misunderstanding."

The All-Wave Monodial

A Short-wave Superhet

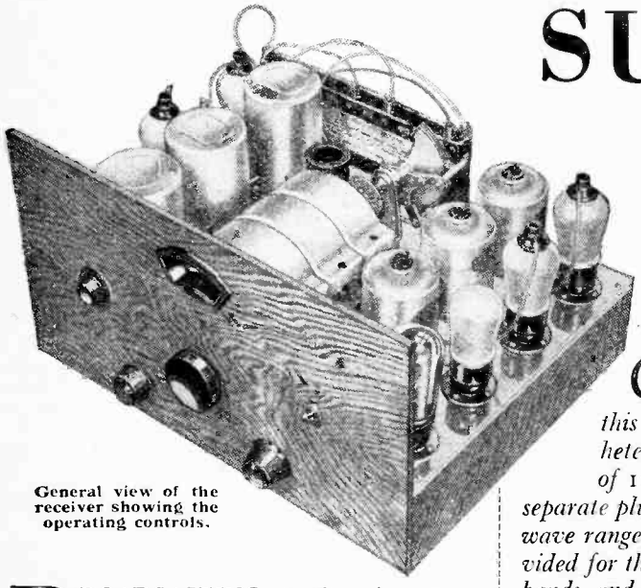
THE WIRELESS WORLD Monodial Superheterodyne, which was first described for A.C. and has since been designed for D.C. operation, has proved an outstanding success, and its reputation is enhanced with every additional set constructed. It is not surprising, therefore, that we have for some months past been receiving frequent requests for a battery version of this receiver to incorporate short waves. This demand we are meeting with a description of such a receiver in this issue. Many of the requests for this set have come from readers overseas whose interest in short-wave reception has increased with the introduction of the Empire broadcasting station.

The reason for adopting a battery design in this instance is first that we have not yet given one in the Monodial superhet range, and, secondly, because for use especially overseas, where mains supply is available, there is a wide difference in frequencies and voltages, and it would not be possible to cover all requirements economically in one mains design

The ALL-WAVE MONODIAL SUPER

An Ultra-selective and Sensitive Battery Set, Tuning from 12.26 to 2,000 Metres

By W. T. COCKING



General view of the receiver showing the operating controls.

CONSTRUCTIONAL details are given in this article for a battery superheterodyne covering the range of 12.26-2,000 metres. Four separate plug-in coils cover the short-wave ranges; built-in coils are provided for the medium and long wavebands, and a switch allows of any one short-wave range to be selected at will. Thus, three ranges are always available without coil changing, giving a maximum of operating convenience.

BROADCASTING to-day is conducted chiefly on wavelengths lying within the limits of 200 metres and 2,000 metres, but there is a number of stations employing considerably shorter wavelengths, and these stations are becoming of increasing importance. The band of 13-100 metres contains numerous broadcasting stations situated in all parts of the world, and phenomenal results are at times obtainable in the way of distant reception.

The results are very largely dependent upon atmospheric conditions, however, so that short-wave reception cannot be said to be reliable when compared with medium-wave broadcasting. Nevertheless, there is an increasing interest being taken in these wavelengths, and for listeners in outlying parts of the Empire they often form the sole wireless link with the outer world.

The design of a receiver including the short, medium and long wavebands within its tuning range is a matter containing problems peculiar to itself. It may be said at once that, in the case of a highly selective and sensitive set, the superheterodyne is the only practical solution. On the medium and long wavebands the use of screened coils is imperative, and these do not lend themselves well to a plug-in arrangement. On the short wavelengths screened coils are unnecessary, extensive switching may lead to inefficiency, and ordinary type variable condensers have too high a minimum capacity to be useful. The best practical solution, therefore, is to employ normal-type coils and condensers for the normal wavebands, and to use a simple switch to change over to plug-in coils and a special condenser for the short wavebands.

Owing to the congestion on the wavelengths between 200 metres and 2,000 metres, a very high degree of selectivity becomes a matter of the first importance, while first-class quality of reproduction, good sensitivity, a low level of background hiss, and a sufficient volume output are also demanded. On the short wavelengths, however, sensitivity becomes the most important factor, with selectivity taking second place, and high

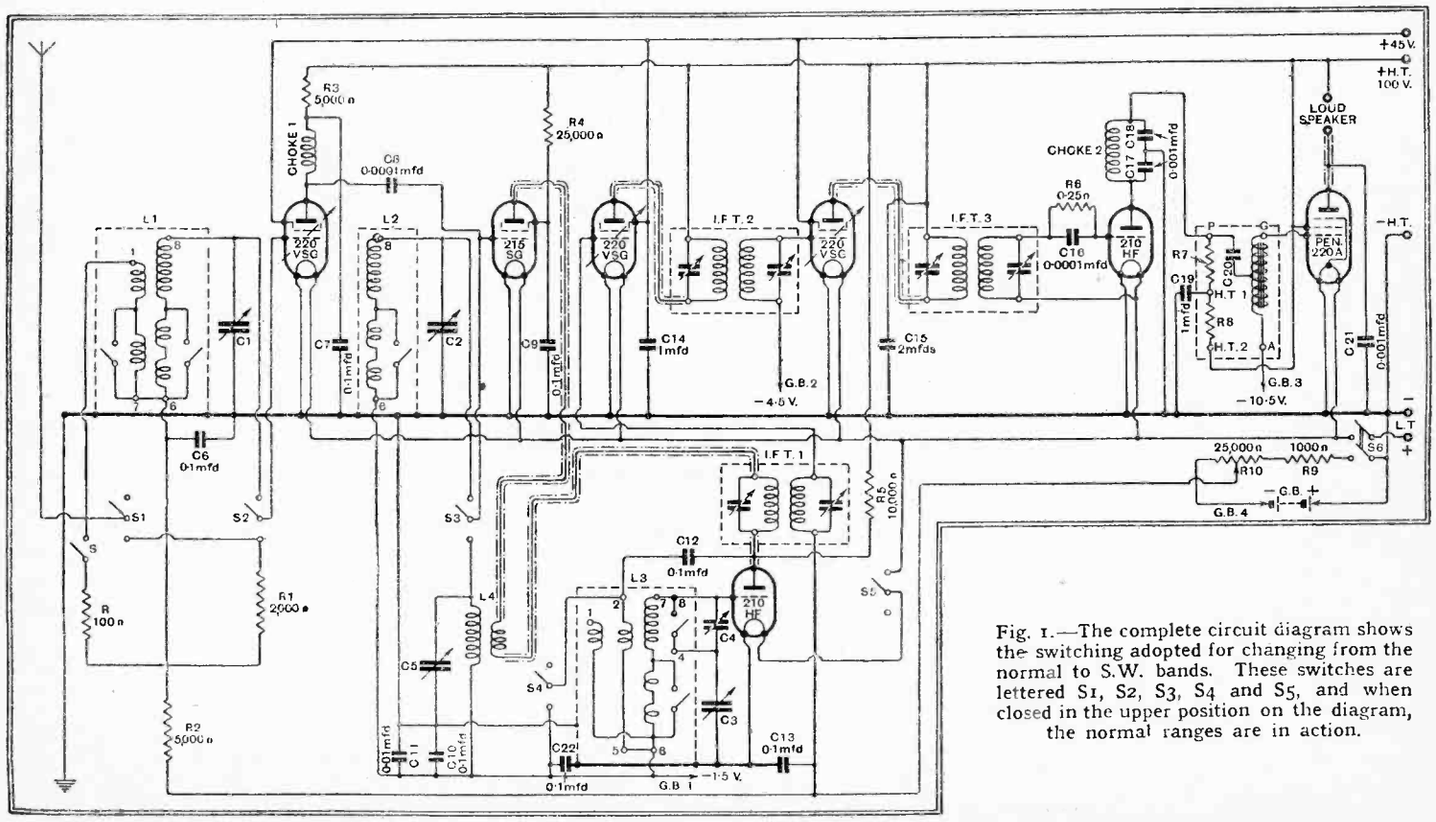


Fig. 1.—The complete circuit diagram shows the switching adopted for changing from the normal to S.W. bands. These switches are lettered S1, S2, S3, S4 and S5, and when closed in the upper position on the diagram, the normal ranges are in action.

quality becomes less important than a low background level, since the incoming signals themselves may often be distorted. Furthermore, on all wavebands the set must be economical in its demands upon the H.T. battery.

Amplification *v.* Anode Current

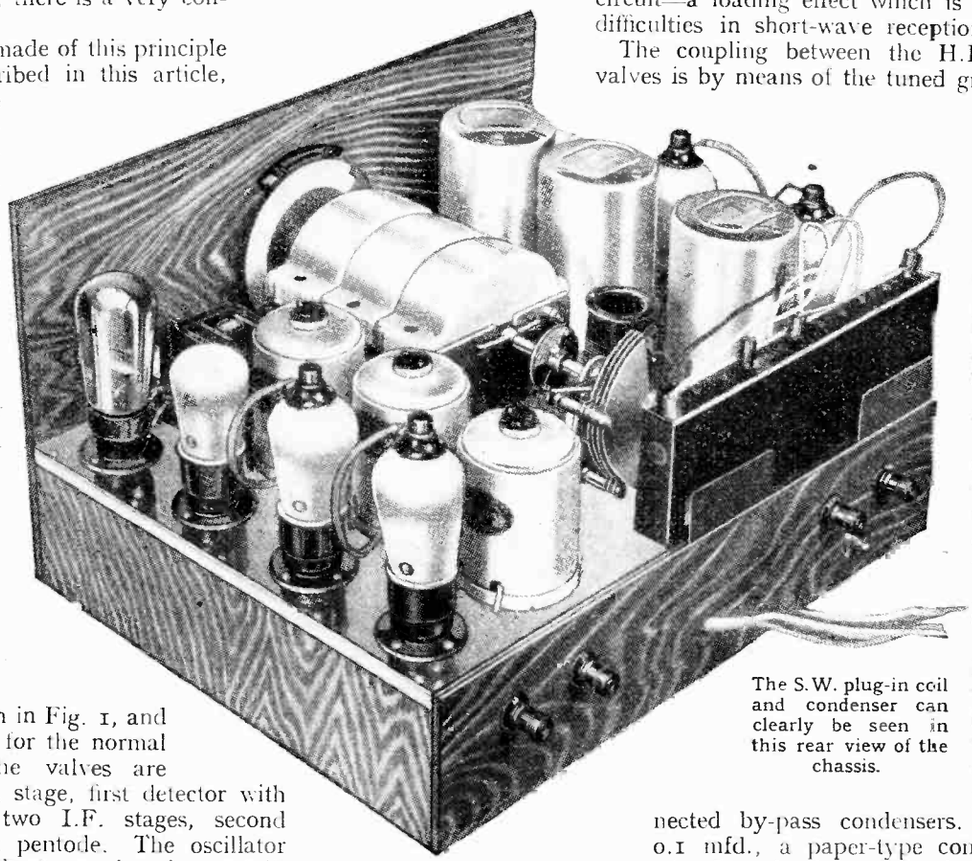
The avoidance of cross-modulation and the attainment of a distortionless volume control necessitate the use of the variable-mu type of valve. To obtain the required amplification with the minimum number of valves, the applied voltages will have to be the optimum rated values. Under these conditions the average battery variable-mu valve takes some 9 mA. total anode and screen currents, and at least two stages are necessary. It would appear, therefore, that the current consumption of the early stages alone would be unlikely to be less than 18 mA. at 150 volts, or a power of 2.7 watts, and this is obviously excessive for a dry battery.

FEATURES

A single-control all-wave superheterodyne for high quality reproduction. Although seven valves are included the H.T. consumption at 100 volts is under 13 mA. and the maximum sensitivity and selectivity are obtained. A variable-mu H.F. stage is employed on all wavebands with a two-valve frequency changer for the medium and long wave-ranges. The autodyne system is used for the short waves.

It is a little known property of the variable-mu valve, however, that a reduction in its anode current, by reducing the screen and anode voltages, does not result in a proportionate decrease in amplification.[1] The current decreases more rapidly than the amplification. Within limits, therefore, it is to be expected that the more valves that are used to obtain a given degree of amplification, the smaller will be their total anode current consumption. It has been found in practice that three variable-mu stages, taking a total of 3.65 mA. at 100 volts, will give more amplification than two stages taking 18 mA. The figure of 3.65 mA. represents the total anode and screen currents of three variable-mu valves, and as the power consumption is now only 0.365 watt, there is a very considerable saving.

Full use has been made of this principle in the receiver described in this article, therefore, and the result is a seven-valve superheterodyne with a total anode current consumption of less than 13 mA. at 100 volts. The increase in the number of valves, of course, means a bigger drain on the L.T. accumulator, and the total current is 1.15 amperes at 2 volts. Since an accumulator can be recharged, however, this is usually of little moment.



The S.W. plug-in coil and condenser can clearly be seen in this rear view of the chassis.

The Circuit

The complete circuit diagram is shown in Fig. 1, and it will be seen that, for the normal broadcast bands, the valves are arranged as an H.F. stage, first detector with separate oscillator, two I.F. stages, second detector, and output pentode. The oscillator is not used on the short wavelengths, and its filament circuit is then opened by the change-over switch, the first detector functioning as an autodyne frequency changer.

The operation will perhaps be best understood if we go over the circuit point by point. The switches S1, S2, S3, S4 and S5 are all linked together and serve to change over from the normal wavebands (200/550 metres and 1,000/2,000 metres) to the short wavelengths. With the switch contacts closed in the upper position on the circuit, the normal bands are in circuit, and the choice between the medium and long ranges is effected by the separate set of switches built into the screened coils.

It will be seen that the variable-mu H.F. valve, a Cossor 220 VSG, is preceded on the broadcast bands by a single-tuned circuit L1, tuned by one section C1 of the three-gang condenser. The aerial is coupled to this circuit, and a local-distance switch S permits a 100 ohms resistance R to be effectively connected between the aerial and earth terminals in order to avoid overloading on a strong local station. The bias on this first valve is controlled by the volume control potentiometer R10, and the grid circuit is decoupled by the 0.1 mfd. condenser C6 and the 5,000 ohms resistance R2. The screen is fed directly from the 45 volts tapping on the H.T. battery, and a 1 mfd. condenser C16 is shunted to earth.

Aperiodic Aerial Coupling

On the short wavelengths little useful purpose is served by tuning the aerial circuit, and, consequently, an aperiodic coupling leads to a considerable simplification. Actually, the grid circuit of the first valve consists of the aerial winding of the broadcast band coil, shunted by a 2,000 ohms resistance R1. The H.F. stage, as one might suppose, contributes little amplification under these conditions, and its chief purpose is to isolate the oscillating circuit of the frequency changer from the aerial. This has the twofold advantage of preventing radiation and of removing the loading effect of the aerial from the tuned circuit—a loading effect which is responsible for many difficulties in short-wave reception.

The coupling between the H.F. and first detector valves is by means of the tuned grid circuit; the choke Ch1 is designed to operate over the whole range of 12-2,000 metres, and on the broadcast ranges a single tuned circuit L2 forms the input circuit of the 215 SG first detector, the coupling to the previous stage being through the 0.0001 mfd. condenser C8. The first detector screen is fed from the 100-volts line through the 25,000 ohms resistance R4, with the 0.1 mfd. by-pass condenser C9 shunted to earth.

The grid-return lead is taken directly to the 1.5 volts negative tapping on the bias battery, but there are two parallel-connected by-pass condensers. These are C10 of 0.1 mfd., a paper-type condenser, and C11, a mica type having a capacity of 0.01 mfd. It is particularly important that this arrangement be employed, for, in spite of the paper condenser being nominally non-inductive, it has too high an internal impedance to be satisfactory at this point in the short wave-ranges; the smaller-capacity mica condenser has actually a lower impedance at the high frequencies involved. On the higher wavelengths, however, the mica

[1] See "H.T. Battery Economy," *The Wireless World*, October 28th, 1932.

The All-wave Monodial Super—

condenser alone would have too great a reactance. The combination, however, proves entirely satisfactory at all wavelengths.

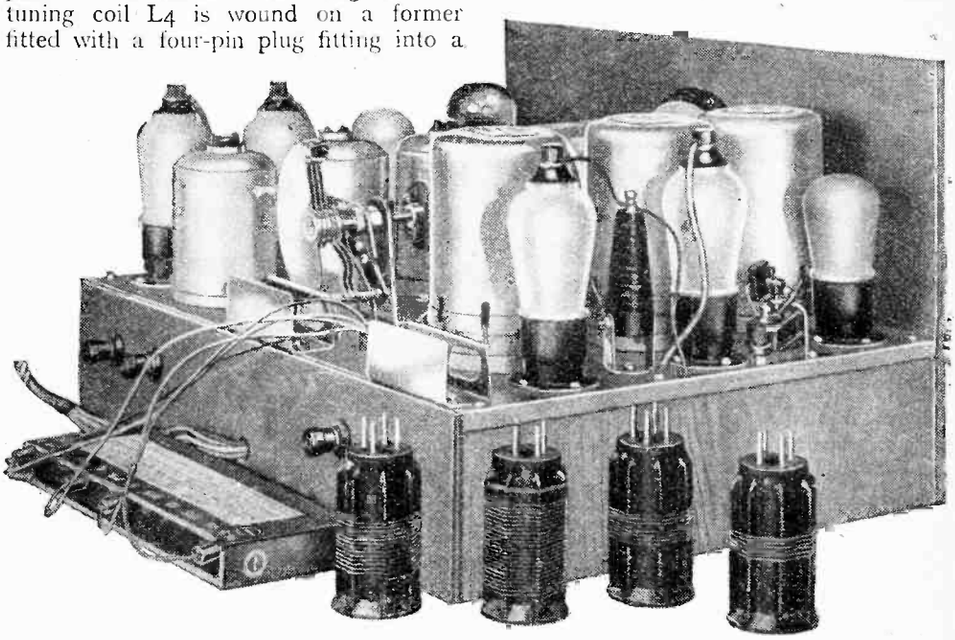
The Frequency Changer

The tuned circuit of the first detector comprises L2 and C2 for the medium and long wave-ranges, and L4 and C5 for the short wavelengths. The condenser C5 is a special short-wave type having a maximum capacity of 0.00016 mfd. and a low minimum; it is mounted directly behind the three-gang condenser and ganged to it, so that a single control knob on the panel serves for all wave-ranges. The tuning coil L4 is wound on a former fitted with a four-pin plug fitting into a valveholder, so that it may readily be changed; four coils are used to cover the range of 12.26-99.25 metres.

As the first detector is worked in an oscillating condition on the short wavebands, a reaction coil is included in its anode circuit, and is actually carried by the same former as the tuned-grid winding. This coil is left in circuit on all wavelengths, in order to avoid additional switching, but, of course, it serves no useful purpose on the broadcast bands. It introduces no undesirable effects, however.

The oscillator valve is a triode of the 210 HF type, and it is associated with the coil assembly L3. The grid circuit is tuned by the condenser C3, a section of the gang condenser having plates so shaped that ganging is maintained on the medium waveband without padding condensers. The reaction coil is shunt fed from the anode circuit by the 0.1 mfd. condenser C12 and the 10,000 ohms resistance R5, and the valve is biased negatively by 1.5 volts. It should be noted that the coil assembly contains a winding that is not used in this receiver, for the coils are of a universal type. Ganging on the long waveband is maintained with the aid of the padding condenser C4, which comprises a fixed and a variable condenser connected in parallel, and which is short-circuited on the medium waveband by a switch built into the coil base.

In addition to the short-wave reaction coil already referred to, the first detector anode circuit includes the primary of the first intermediate-frequency transformer. One end of this is joined directly to the oscillator anode, so that the oscillator reaction coil and C12 are effectively in the first detector anode circuit. The oscillator, therefore, is coupled to the anode circuit of the first detector, and this has been found to be the only entirely satisfactory method with battery-type valves. In consequence of this arrangement, the first detector need be given a grid bias no greater than would be used for amplifying, and there is a complete absence of interaction between the signal frequency and oscillator trimmers, so that ganging does not become difficult. Since it is not permissible for the oscillator reaction coil to remain in circuit on the short wavelengths, it is fitted with a short-circuiting switch S4.



The all-wave H.F. choke for the tuned-grid coupling is mounted between the H.F. and 1st detector valves. In the foreground are seen the short-wave plug-in coils.

The I.F. Amplifier

The I.F. amplifier is entirely straightforward, and two variable-mu valves are employed. Their anodes are fed directly from the 100-volts line with a by-pass condenser C15 of 2 mfd., and the screen grids are connected to the 45-volts tapping on the H.T. battery. All the couplings are identical, and there is a total of three I.F. transformers, each containing two tuned circuits of the band-pass type resonating at 110 kc. The bias on the first I.F. valve is controlled from the volume-control potentiometer R10, in common with the H.F. valve, but the second I.F. valve is not controlled and is worked with a fixed bias of 4.5 volts. This is in order to avoid the distortion which sometimes occurs when too great a range of control is attempted.

The bias potentiometer has a resistance of 25,000 ohms, and a fixed resistance R9, of 1,000 ohms, is included in series with it in order to give a fixed minimum bias. This is set at such a value that, with the control very nearly at maximum, the I.F. stages begin to oscillate through the inherent stray couplings. The set, therefore, is not quite stable at the maximum setting of the volume control, and this is definitely a desirable feature in a short-

LIST OF PARTS REQUIRED

After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Three-gang Superhet condenser, 0.0005 mfd. **Polar "Star"**

1 Short-wave variable condenser, 0.00016 mfd., C5 **Eddystone No. 922**

1 Special bracket for short-wave condenser **Peto-Scott**

1 Slow-motion dial **Eddystone No. 933**

1 Insulated coupling (Ormond) **Cyldon**

1 Compression type condenser, 0.002 mfd., C4 **Polar "Preset"** (Formo, R.I.)

1 Set of Superhet coils **Telsen S339**

1 Set of short-wave coils comprising 1 L.B., 1 Y, 1 R, and 1 2BB **Eddystone No. 932**

3 I.F. transformers, 110 k.c. **Varley BP21** (Colvern, Wearite)

1 H.F. choke, Ch1 **Eddystone No. 505**

1 Screened H.F. choke, Superhet type, **Ch2 Bulgin H.F.10** (Wearite)

1 Switch, ganged, on special brackets, **S1, S2, S3, S4, S5** **Wearite 132/132/132**

1 Single-pole switch Q.M.B., S **Bulgin S.80** (Claude Lyons)

1 Two-pole switch Q.M.B., S6 **Bulgin S.88** (Claude Lyons)

1 Potentiometer, 25,000 ohms, R10 **Igranic No. 2235/7** (Colvern, Wattmel)

1 Resistance, 100 ohms, 1 watt, R **Claude Lyons**

1 Resistance, 1,000 ohms, 1 watt, R9 **Claude Lyons**

1 Resistance, 2,000 ohms, 1 watt, R1 **Claude Lyons**

2 Resistances, 5,000 ohms, 1 watt, R2, R3 **Claude Lyons**

1 Resistance, 10,000 ohms, 1 watt, R5 **Claude Lyons**

1 Resistance, 25,000 ohms, 1 watt, R4 **Claude Lyons**

1 Resistance, 250,000 ohms, 1 watt, R6 **Claude Lyons** (Dubilier, Erie)

1 Fixed condenser, 0.01 mfd. mica, C11 **T.C.C. No. 34**

3 Fixed condensers, 0.001 mfd. mica, C17, C18, C21 **T.C.C. No. 34**

1 Fixed condenser, 0.001 mfd. mica, C4 **T.C.C. type "M"**

2 Fixed condensers, 0.0001 mfd. mica, C8, C16 **T.C.C. No. 34**

7 Fixed condensers, 0.1 mfd. non-inductive 400 v. D.C. test, C6, C7, C9, C10, C12, C13, C22 **T.C.C. No. 50**

2 Fixed condensers, 1 mfd. non-inductive 400 v. D.C. test, C14, C19 **T.C.C. No. 50**

1 Fixed condenser, 2 mfds. non-inductive 400 v. D.C. test, C15 **T.C.C. No. 50** (Dubilier, Telsen)

1 Coupling unit **R.I. "Parafeed"** (Benjamin, Bulgin)

8 Valve holders, 5-pin **Clix, chassis-mounting type** (Bulgin, Burton, Eddystone, W.B.)

1 Battery cable, 5-way, 30in., with wander plugs marked GB+, GB—1, GB—2, GB—3, GB—4, **Belling-Lee** (Bulgin, Concord, Coltone, Harbros, Lewcos)

1 Battery cable, 5-way, 54in., with spade ends marked LT+, LT— and wander plugs marked HT—, HT+1, HT+2 **Belling-Lee** (Bulgin, Concord, Coltone, Harbros, Lewcos)

1 Connector, 5-way **Wilburn**

1 Grid-bias battery, 16½ volts

1 pair G.B. battery clips **Cripso** (Bulgin, Burton, Ormond)

4 Ebonite shrouded terminals, aerial, earth, LS+, LS— **Igranic "Indigraph"** (Belling-Lee, Burton, Clix, Eelex)

2 lengths Screened sleeving **Coltone** (Concord, Harbros, Lewcos)

Plymax baseboard, 12in. x 16in. x ⅝in. **Peto-Scott**

Panel, oak-faced ply, 9in. x 16in. **Peto-Scott**

Plywood, ⅜in., 12 length Systoflex, 2ozs. No. 20 tinned copper wire, etc.

Wood screws, 39 ⅝in. No. 4 R/hd., 14 ¼in. No. 4 R/hd., 19 ⅜in. No. 4 R/hd., 22 ¾in. No. 4 R/hd., 6 1¼in. No. 4 C/sk.

Metal screws, 4 ¼in. No. 4 B.A. with nuts and washers, 5 ¼in. No. 5 B.A. with nuts and washers.

1 H.T. battery, 165 volts **Ever Ready Popular Power type**

Valves, 3 Cossor 220 VSG or Marconi or Osram VS2, 1 Cossor 215 SG or Marconi or Osram S21, 2 Cossor 210 HF or Marconi or Osram HL2, 1 Mazda Pen. 220A.

The All-wave Monodial Super

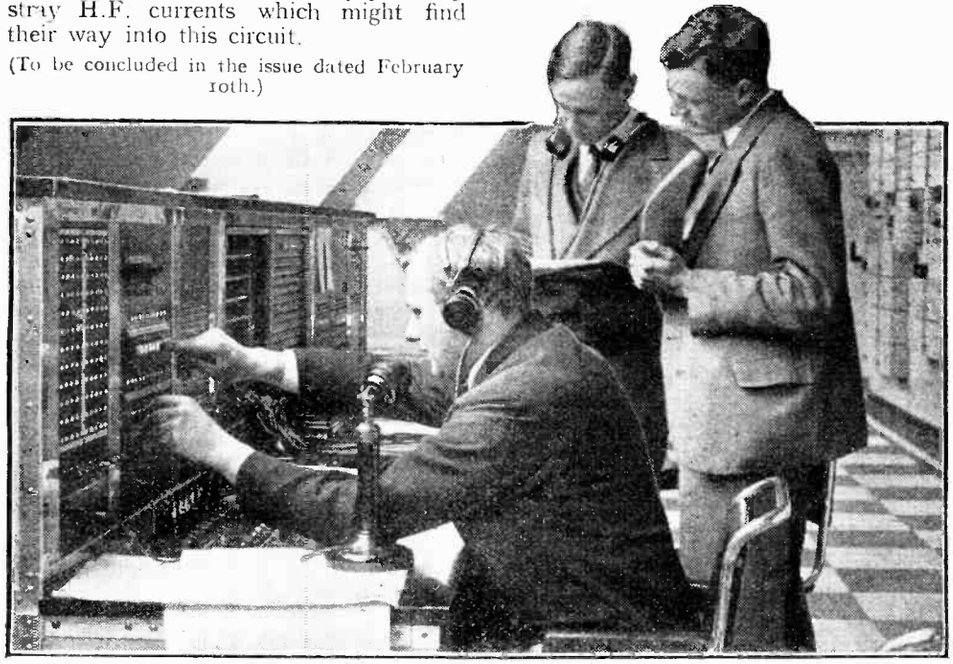
wave set, since it renders searching much easier. When searching, the set is used in the oscillating condition, and whenever a station is passed over the familiar whistle can be heard; the station can then be tuned in accurately, and the volume-control setting reduced until stability is reached. For reception of continuous-wave telegraphy it is essential to use the set in the oscillating condition.

The Second Detector

Grid rectification is used for the second detector, and the valve is a triode of the 210 HF type; the usual I.F. filter, comprising the choke Ch2 and the two 0.001 mfd. condensers C17 and C18, is fitted in the anode circuit. The coupling to the output pentode is by means of a 4-1-ratio auto-transformer, and the component actually employed is a coupling unit containing the transformer, the coupling condenser C20, and the two resistances R7 and R8. The values of these are marked on the circuit in case it is desired to make use of an existing transformer, with which separate components would be needed.

The output valve is a Mazda Pen 220A, worked with 100 volts for the anode and screen supplies, and some 9 to 10½ volts grid bias. With the higher bias voltage the anode and screen currents total only 4 mA., but a surprisingly large volume of sound is obtainable when a correctly matched and sensitive speaker is used. A load impedance of 8,000 ohms is required, so that the ordinary pentode transformer is satisfactory. No pentode compensator is necessary, for the high-frequency-accentuation of the pentode is employed to correct for the sideband cutting of the I.F. circuits, thus giving automatic tone correction. A 0.001 mfd. condenser is connected between the pentode anode and earth to by-pass any stray H.F. currents which might find their way into this circuit.

(To be concluded in the issue dated February 10th.)



AT THE CENTRE OF AFFAIRS. All programme efforts in the studios, as well as all outside broadcasts, find their way to the control room at Broadcasting House, seen in the photograph. The engineer is seated at one of the S.B. desks.

In Next Week's Issue:—

AMPLIFIER DESIGNS

Two Units for the Home Constructor

FULL constructional details of two small amplifiers designed especially for gramophone reproduction will be included in next week's issue. There is much in favour of using a separate unit for this purpose, although many modern receivers offer similar facilities, but often they are not very conveniently placed, since of necessity the receiver must be reasonably close to the aerial lead-in and an earth connection.

In the one case the amplifier is operated entirely from the D.C. mains and, of course, includes the latest types of indirectly heated D.C. valves. It is a two-stage amplifier and will deliver a comparatively large power output.

The other model is a battery unit, and employs for the output stage two small pentodes working in quiescent push-pull. The remarkable results now obtainable with this system enable those who are dependent upon batteries to enjoy reproduction comparable in quality and volume to that of a well-designed mains-operated amplifier.

LISTS OF PARTS.

After the particular make of component used in the original model, suitable alternative products are given in some instances.

D.C. GRAMO-AMPLIFIER

3 5-pin Valve holders, chassis mounting type **Bulgin VH7**
(Clix, Eddystone, W.B.)

2 Chokes, 15 henrys, 100 milliamps **Bulgin LF21**
(Ferranti B1, Igranic C80, R.I. 28/14 henrys)

1 Mains resistance **Bulgin MR5**

1 Volume control, 50,000 ohms **Colvern type ST10**
(Igranic, Lewcos, Rotorohm, Varley, Watmel, Wearite)

5 Fixed condensers, 1 mfd., 250 v, D.C. working **T.C.C. type 65**

3 Fixed condensers, 2 mfd., 250 v, D.C. working **T.C.C. type 65**

1 Fixed condenser, 4 mfd., 250 v, D.C. working (Dubilier type BB, Goltone, Wego) **T.C.C. type 65**

1 L.F. coupling unit **R.I. "Parafeed"**
(Bulgin "Transcoupler")

1 2-pole mains switch **Bulgin S88**
(Claude Lyons)

2 Metallised resistances, 100 ohms, 1 watt **Dubilier**
2 Metallised resistances, 250 ohms, 1 watt **Dubilier**
1 Metallised resistance, 1,000 ohms, 1 watt **Dubilier**
2 Metallised resistances, 5,000 ohms, 1 watt **Dubilier**
1 Metallised resistance, 50,000 ohms, 1 watt **Dubilier**
1 Metallised resistance, 100,000 ohms, 1 watt **Dubilier**
(Erie, Claude Lyons)

1 Twin safety fuseholder with 1 amp. fuses
(Bulgin F11) **Belling-Lee No. 1033**

4 Ebonite shrouded terminals **Belling-Lee type "B"**
(Burton, Clix, Eelex, Igranic)

1 Adaptor **Goltone R80/90**

Wood, Systoflex, small quantity 20 tinned copper wire, flex, etc. Wood baseboard, 11½ x 9½ x ⅝in.

Screws: 26 ¼in. No. 4 R/hd.; 10 ⅜in. No. 4 R/hd.; 2 ⅝in. No. 4 R/hd.

Valves: 1 DH, 2 DPT **Marconi**
(Osram)

Q.P.P. GRAMO-AMPLIFIER

3 5-pin Valve holders **W.B. type "A.C."**
(Benjamin, Fersanti, Junit, Lotus, Wearite)

1 Push-pull L.F. transformer, 1:7 **Ferranti AF6c**
(Multitone 1:9 ratio, R.I. model DY34. Sound Sales 1:9 ratio Varley)

1 Resistance, 10,000 ohms, 1 watt **Erie**
1 Resistance, 20,000 ohms, 1 watt **Erie**
1 Resistance, 50,000 ohms, 1 watt **Erie**
1 Resistance, 150,000 ohms, 1 watt **Erie**
(Dubilier, Claude Lyons)

1 Fixed condenser, 0.01 mfd. mica **Graham Farish**
(Dubilier, T.C.C., Telsen)

1 Fixed condenser, 2 mfd., 700 v, D.C. test **Wego**

1 Volume control, 25,000 ohms **Igranic No. 2235/7**
1 Volume control, 50,000 ohms **Igranic No. 2235/8**
(Colvern, Lewcos, Rotorohm, Varley, Watmel, Wearite)

1 3-point Switch **Goltone R26/745**
(Junit, Telsen, W.B.)

2 Grid bias batteries, 9 volt
1 pair Grid bias battery clips **Bulgin No. 7**

2 Insulated terminals **Clix "All-in"**
(Belling-Lee, Burton, Eelex, Igranic)

1 6-way Battery cable, 30in. **Goltone "Court" R40/16**
(Belling-Lee, Bulgin, Harbros, Lewcos)

5 Wander plugs **Clix "Master" type "B"**
(Belling-Lee, Eelex)

Wood, Systoflex, small quantity 20 tinned copper wire, etc. Wood baseboard, 7½ x 8 x ⅜in.

Screws: 5 ¼in. No. 4 R/hd.; 4 ⅜in. No. 6 R/hd.; 6 ⅝in. No. 4 R/hd.; 5 ¼in. No. 4 C/sk.

Valves: 2 Mazda Pen 220A, 1 Cossor 210 HF, or Mazda HL210, or Marconi HL2 or Osram HL2, or Mullard PM1HL.

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BOOKS RECEIVED

Accumulator Charging, Maintenance, and Repair, by W. S. Ibbetson, B.Sc., A.M.I.E.E., M.I.Mar.E. 3rd Edition, enlarged and brought up to date to meet the requirements of portable wireless receivers, motor vehicles, emergency batteries in cinemas, theatres, and hospitals, with a chapter on alkaline cells. Pp. 128+12, with 36 illustrations and diagrams. Published by Sir Isaac Pitman & Sons, Ltd., London. Price 3s. 6d.

Report of the Radio Research Board for the Year 1931.—A review of Investigations on the Propagation of Waves, Directional Wireless, Atmospherics, Aerials, Ultra-short Waves, Standards, Measurements, etc. Pp. 123+iv. Published by H.M. Stationery Office. Price 2s.

Rundfunk Jahrbuch, 1933.—Giving a general résumé of the progress of Broadcasting in Germany, and the principal events of interest during the past year. Pp. 167, with many illustrations. Published by the Reichs-Rundfunk, Gesellschaft, Berlin.

The Choice of L.F. Couplings

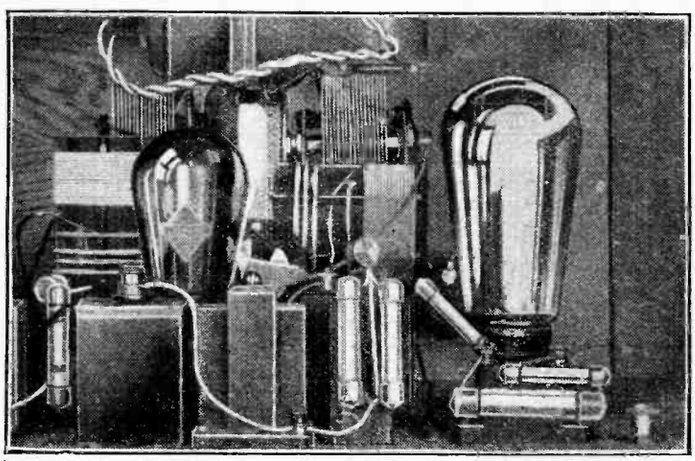
Why the Parallel-fed Transformer is Popular

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

THERE are certain things about broadcast reception that have not changed very much for a long time. Long, that is to say, in a history which is compressed into ten years. Therefore these things are usually "taken as read," and published articles forge ahead with more recent events. That is all very well for those who have followed the art from the beginning, but excessively perplexing to those who have not. They are faced with all manner of practices for which no explanation is given, save that "it was done of old time."

"WHICH is the best L.F. coupling to use?" is a question often asked, but not always easily answered. So many conflicting requirements are at stake, and the would-be adviser now has so many methods from which to choose. To resistance, choke and ordinary transformer coupling we must now add parallel-feed and auto-coupling to complicate the choice. This article furnishes a simple explanation of the systems and enumerates the relative advantages of each.

It is fairly easy to grasp, for example, the fact that valves are capable of amplifying weak impulses almost without limit, so that the feeble waves received from distant transmitting stations can be magnified to an extent which may verge on a menace to the neighbouring civilisation. It is less clear why the valves should be interspersed with other parts, which though diverse in character appear to accomplish much the same result; such items as intervalve transformers, chokes, resistors and condensers, varied in these latter days by devices with names based on every possible combination of the words "parallel," "feed," and "transformer." Why not simply connect one valve to the next, or, if extra gear really is necessary, why not settle on the best method and stick to it?



A resistance-coupled stage of *The Wireless World* "Power Radiogram."

Like firearms, valves depend on a relatively small impulse to release a much larger amount of power. One tiny "automatic" fires a diminutive bullet at the trigger of an elephant gun, which in turn touches off something really violent that makes a noise like a loud speaker in full cry. But such a system would be found to be rather crude owing to the unsuitable method of applying the weaker power to the controlling trigger of the larger.

In the same way the direct connection of one valve to the next would fail, because the power released from the one is not in a form which is available for driving its successor. A stream of water merely flowing along is quite useless for driving machinery; it has to be made to exert a *pressure* by impinging on the blades of a wheel or otherwise.

Just so the current impulses from one valve, say the detector, which are themselves seldom powerful enough to work a loud speaker, are made to meet some sort of obstruction, and the pressure (or voltage as it is called in electrical circles) which it is thus obliged to exert is passed on to the next valve. An intervalve coupling, then, comprises two things: something to obstruct electric currents of the type emerging from the outlet or anode of the detector valve, and something to pass them on to the trigger or grid of the next valve, usually the last in a set. The part that does the passing on must also abstain from upsetting the working condition of the valves, which require a constant positive voltage on the anode, and negative on the grid.

The obstruction may take the form of a resistor, which develops across its ends a voltage which is proportional to the current flowing through it, irrespective of whether the current is steady, such as the constant feed which is necessary for the valve to work at all, or varying in the manner necessary to convey an imitation of talking or playing.

Therefore the passing-on must be accomplished by some device which presents the talking, etc., effects to the grid of the next valve, but acts as a complete stoppage to the unvarying voltage caused by the feed current. Such discriminating abilities are possessed by the appliance known as the condenser, which is accordingly used to connect anode to succeeding grid. All that remains to be done is to ensure that the grid is connected also with its supply of steady negative voltage, and for this purpose one uses a resistor so high in obstructing power or resistance that it

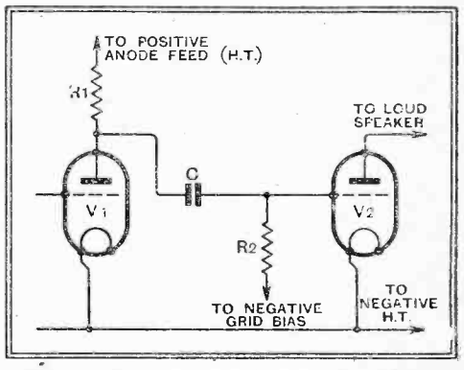


Fig. 1.—Resistance coupling was in common use ten years ago and still finds considerable application.

prevents serious leakage of the "signal" voltages. So we arrive at the circuit of Fig. 1, in which V1 is the first valve, V2 the second, R1 the anode resistor, C the condenser, and R2 the grid resistor or "leak" (although in this particular case it is intended to make the leakage as small as possible).

A Compromise

This system—resistance coupling—is in common use to-day, and was so ten years ago and more. It has certain disadvantages, nevertheless.

The valve itself, V1, offers some resistance, so that part of the possible output is witheld and absorbed internally, and thereby lost. When R1 is made very large—in resistance, that is to say, not in actual size—the valve resistance is a relatively small part of the total, and the lost amplification therefore small. But a large R1 necessitates extra battery volts to preserve the flow of feed current undiminished, otherwise the amplification slumps through valve starvation.

Beyond a certain point the amplification thus salvaged does not justify the expenditure on batteries or power

The Choice of L.F. Couplings—

equipment. So the amplification is always rather less than the figure that the valve manufacturers give on their leaflets and catalogues. Moreover, the go-between condenser does not help to make up for such losses by giving the signal voltages a boost before passing them on; in fact, if it is not made sufficiently large it holds back a bit on its own. Worse still, it holds back the low tones more than the high, and thus upsets the balance of tone. But this effect can be made negligible by using a suitable condenser.

The leak R2 likewise reserves a bit to itself, but not enough to matter if its resistance is large enough.

The beauty of the method is the equality with which R1 treats all that it handles; there is no prejudice in favour of high, low, or middle notes. And, in spite of the necessity for three items, it is quite cheap.

The next method, choke coupling, was devised to overcome the first drawback. A choke is the opposite to a condenser, in that it freely passes an unvarying current but obstructs the varying ones which represent the broadcast we desire to hear. It therefore seems ideal, for no extra battery volts are required. Unfortunately, it distinguishes not only between fixed and varying currents, but between currents varying at different rates, so that to the fast-moving or soprano currents it acts as a very efficient barrier, extracting almost the whole of the amplification from the valve, while the bass notes, which vibrate so slowly as to seem more like the steadily flowing battery current, are permitted to pass without delivering up all of which they are capable.

The only way to prevent this inequality from becoming noticeable as shrillness of reproduction is to design the choke so as to be an almost complete obstruction to even the lowest notes. Suppose it is then 90 per cent. effective; the highest note

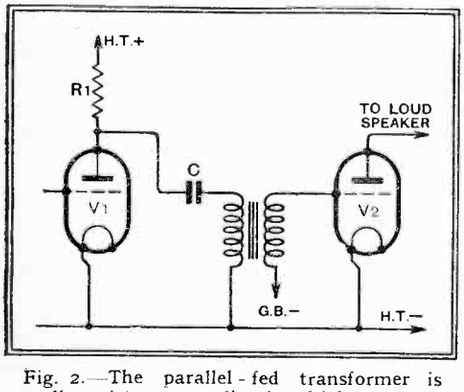
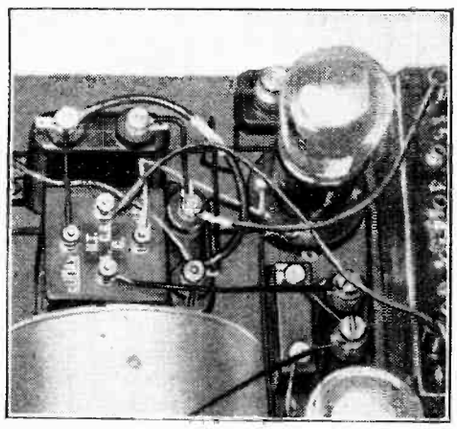


Fig. 2.—The parallel-fed transformer is really resistance coupling in which a step-up transformer replaces the grid leak.

in the musical scale cannot be amplified more than, or even quite as much as, 100 per cent.; and the difference in amplification between these two extremes of frequency is therefore too small to be appreciable.

To fulfil this requirement the choke must have a very large inductance, which means a very large number of turns of wire on a substantial core of rather special iron, and by the time that has been done the choke costs more than all the three pieces needed for resistance coupling. And the other two must still be retained for choke coupling. So the little extra amplification is paid for rather dearly, and these times of financial stress have proved too severe for the method to find really considerable application.

The circuit diagram is the same as Fig. 1 except that R1 is a choke instead of a resistor. R2 can also be replaced by a choke, but there is no particular advantage in doing so, unless the two chokes are wound closely together on one iron core. Then it is found that the voltage developed across one is mysteriously reproduced across the other without any need for the condenser link. More than that, if, for every turn of wire on the first winding, several are put on the second, the voltage applied to the grid is several times as great as that reaped from the first valve. This very useful double choke, which is generally known as a transformer, can be made to give a four-, five-, or even eight- or nine-fold step-up, which means that quite a modest detector valve can be made to run a large power valve on full throttle. A still greater multiplying power leads to difficulties in design and construction.



In *The Wireless World* "Battery V-M Three," a section of which is illustrated, "straight" transformer coupling was used.

Why Parallel-feed?

It is true that the transformer does not deal quite so faithfully with music as does a resistance coupling, but only the very cheap sorts announce their imperfection unmistakably. Moreover, one valve with a transformer can be made to do what might require two valves with resistance couplings, so a very good and expensive transformer may actually prove an economy. Such transformers used to be rather bulky, but by using a special alloy of iron and nickel, which had been invented for something else, it was found possible to make a transformer small, good, and cheap—all at once. It need hardly be pointed out that this miracle was not accomplished without introducing a brand-new disadvantage; namely, that when the valve No. 1 is fed with enough steady current to ensure satisfactory nourishment as a detector the transformer forthwith becomes just an ordinary bad one, for what is one valve's meat is another transformer's poison.

This set-back, after a moment's quick thought, resulted in a combination of resistance and transformer coupling, generally known as parallel-feed.

This is shown in Fig. 2, in which it will be seen that it starts off in true resistance fashion, going even so far as the condenser; but instead of the leak, for which the most that can be said is that it does not waste *much* of the signal voltage entrusted to it, there is the transformer with the nickel-iron core, and as the condenser is there to protect it from the paralysing influence of the non-varying battery current to valve V1 it works under ideal conditions, and yields a dividend of several hundred per cent. in the form of increased output to valve V2.

Fig. 3 shows a still better idea, for it pays not only this very satisfactory rate of interest, but throws in the principal as well, so that if the transformer is normally a 1-to-3 step-up this connection gives 1 to 4.

Compared with resistance coupling, parallel feed retains the disadvantage of loss of amplification (or need for high battery voltage), and costs more by the difference between a transformer and a grid leak, and, theoretically, the quality is not quite so good; but the loss of amplification is more than reimbursed by the step-up of the transformer, to such an extent that the cost of a whole valve may be saved, thus more than paying for the transformer, and the latter is working under such splendid conditions that any audible difference in quality as compared with resistance coupling may, in most cases, be held due to a vivid imagination.

Whether parallel feed has any advantage over straight transformer coupling

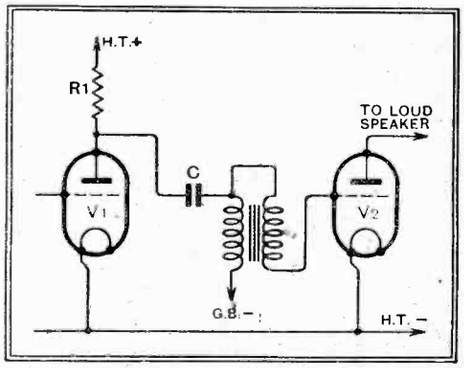


Fig. 3.—A parallel-fed transformer can give more than the nominal step-up ratio if it is auto-coupled.

is mainly a question of cold finance. Choke coupling is hardly in the running at all, being handicapped by most of the disadvantages, and with only one minor advantage as compensation. Plain resistance coupling is all right if the amplification of one valve is enough. If valves improve much more it may become universal.

Gas Manager's Troubles—II

THE desperate dilemma of my friend the gas manager, which I related in the January 6th issue of this journal, has been solved in a completely satisfactory and somewhat unexpected manner. His release from his trouble is due to the kindness of a reader living at Welling, in Kent, who suggested that he might find his salvation in quiescent push-pull. At first I could not quite see what was meant until it suddenly dawned on me that the idea was for my friend to turn honest and really install a battery-driven receiver capable of giving practically the same output as his concealed mains receiver.

I quickly conveyed this suggestion to him, and although at first he basely accused me of being a dog fancier he agreed to try it. Our efforts were at first unsuccessful, and my friend rather bitterly remarked that the word "quiescent" was a singularly apt one to be applied to the receiver. Fortunately I soon found a rather foolish error which he had made in wiring up, and the final results are best described by saying that he has now dismantled his mains set and is fearlessly dishing out the circuit to all enquirers.

Tit for Tat

I WAS interested in the proposal, recently put forward by the French Motor Manufacturers' Association, that heavy lorries should be fitted at the back with a microphone coupled *via* an amplifier to a loud speaker mounted close to the driver's ear, so that he could hear the horns of vehicles desiring to overtake.

Tit for tat.

I fear, however, that the device would be the inevitable instrument for the conveyance of abusive language. In common fairness to the driver, I think he should be supplied with a microphone coupled to a loud speaker at the rear, so that he could retaliate. It would, at any rate, add to the gaiety of motoring even if it did nothing else.

An Electric Clock

HARDLY had the ink dried on the heart-rending appeal which I issued on January 6th for an A.C.-mains clock fitted with a synthetic tick than the required instrument came along from the Synchronome Company. Not only does it possess a stately tick worthy of a grandfather clock, but the large centre seconds hand advances in the time-honoured way from second to second, completely banishing the ghostly effect of which I complained. Moreover, the whole mechanism is electrically driven, no "clockwork" being employed to produce this effect.

It is very gratifying indeed to have to place on record an outstanding example of enterprise and initiative of this sort, more especially when it concerns one of our own manufacturers. Even among foreigners, however, the spirit of enterprise has not been lacking, and two Chicagoans—one of them a famous amateur brass pounder—have spared time from their orgy of slaughter to offer me their services in this matter.

There is still one omission, however, which prevents the word perfection being applied even to this clock, and, curiously enough, it is a very "glaring" one of which all the makers of these devices seem to be guilty. Not one of them has, so far, seen fit to employ a translucent face with a small electric light behind it, as in the case of a tuning dial.

A small one-watt lamp would provide ample illumination at a cost of only a penny per week, even at lighting rates. I wonder what manufacturer will be the first to fulfil this need. I trust that no attempt will be made to fob us off with the usual phosphorescent arrangement, but that a proper miniature Big Ben will be produced.

A Burning Question

YOU will rejoice with me that I succeeded in cutting short a threatened attack of 'flu the other day by taking to my bed at the first premonitory symptoms. Feeling the need of extra heat I thought I would try the effect of an electric blanket, and duly dispatched Mrs. Free Grid to get one. Within five minutes of its arrival I was enjoying the cosy comfort of its warmth and preparing to fall asleep.

I had scarcely closed my eyes, however, before I was informed that loud cracklings were occurring in the wireless set every time I flicked an eyelid. This I found was the case. Appreciable noises coincided with the rhythmic rise and fall of my midriff, and every turn of the body produced a deafening series of crashes like the breaking of ten thousand cups. Loose connections was the obvious diagnosis, and swift work with a magnifying glass quickly confirmed it. It was indeed a mercy that I was not burnt alive in my bed.

The trouble was due, as I might have expected, to the failure of Mrs. Free Grid to realise the truth of the old saying that all that glitters is not gold. Instead of carrying out my carefully worded instructions concerning the type and make of blanket she was to buy she had been led astray by a "glowing" account she had read of a cheap and nasty device of foreign origin. I may say that the article has since been changed for another one made by a well-known firm, and all interference with wireless has ceased. I am now wondering how much of the man-made static with which we are troubled is due to the use of cheap and nasty bed warmers.

Swift work.

Ether Shocks

WHILE I can hardly be accused of narrowmindedness in a Chadbandian sense I really do think that there is a limit to which Continental stations may be permitted to go in broadcasts intended for English ears, particularly those of juveniles. I make this protest as a direct result of a programme recently broadcast in which attention was directed to the lofty moral standards now being adopted by the youth of a certain Continental country.

It so happened that when this particular broadcast came on the air I was reading and unfortunately misunderstood the facial contortions which Mrs. Free Grid directed towards me. She was, as I found out later, endeavouring to indicate that the programme should be changed before certain of the little Grid Leaks became too interested in its subject matter. Unfortunately, I interpreted her signals as a demand for more volume and consequently precipitated a minor domestic disturbance.

Keyboard and Loud Speaker

How the "Neo-Bechstein" Piano Works

By R. RAVEN-HART

DURING a recent visit to Berlin the writer enjoyed the opportunity of hearing the "Neo-Bechstein" piano specially demonstrated and also of examining and playing it himself. The instrument looks like a small grand piano, with absolutely normal keyboard and touch, together with a separate loud speaker.

Nothing could be more simple in its essentials: a steel string is struck as in the case of a normal piano, and vibrates within the field of an electro-magnet (one such taking care of five notes). The resulting electrical impulses in the coils of this are then amplified and fed to the loud speaker, the degree of amplification being controlled by the left pedal.

Normal Piano Technique

The refinements are, in fact, chiefly mechanical. First, the string need vibrate only to a very small extent, since it has to produce very little energy; hence it can be shorter, lighter, and less tensioned than the normal. Double strings are used only in part of the middle register, triple ones not at all. This, of course, implies a lighter framework, also a lighter hammer. In order, however, not to change the normal piano technique, hammers of the usual weight are used, but these do not hit the string directly, but a bar nearby, and this impact drives a tiny hammer, perhaps one-twentieth the weight of a normal one, up to hit the string itself. Incidentally, the tone is purer owing to the reduced amplitude of the vibrations.

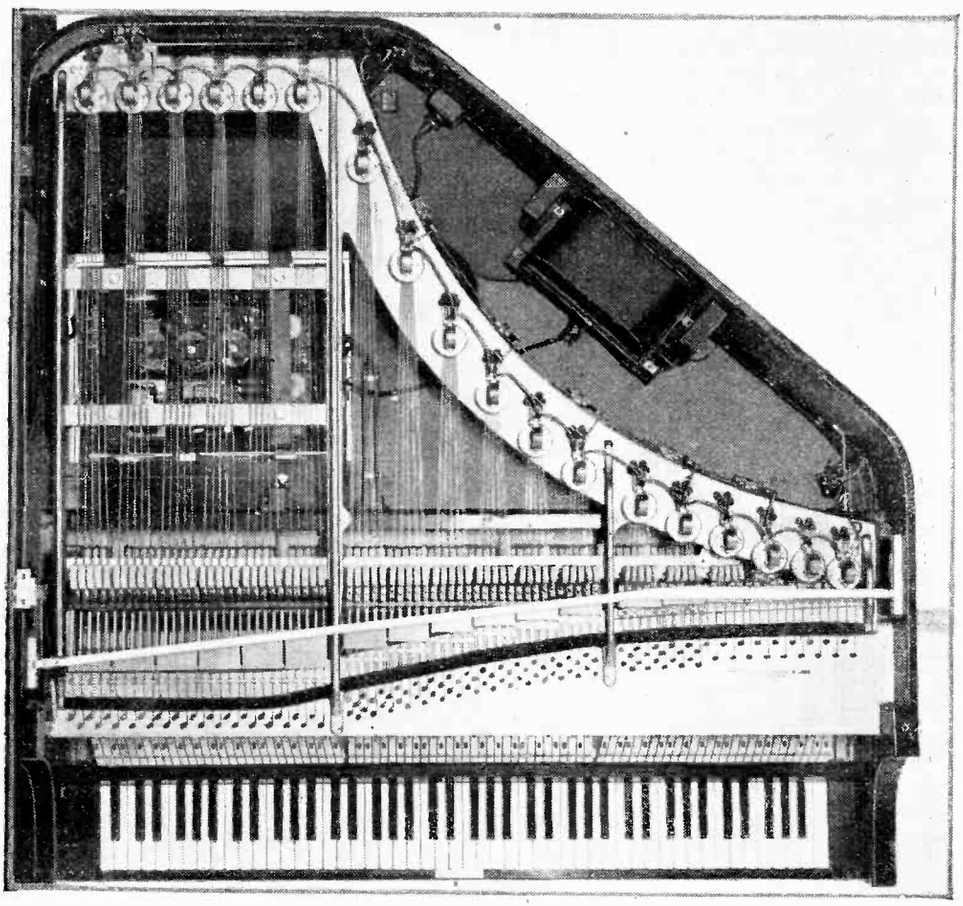
THE "Neo-Bechstein" electrical pianoforte, which may shortly make its appearance on the British market, is here described by a correspondent who has both heard and played the instrument in Germany. Of special interest is the wide variation in apparent tone colour, ranging from spinet effects to those of the organ, saxophone and banjo.

Again, as the strings are giving off practically no energy, their damping is greatly reduced; a bass string will vibrate for something like a minute after striking. This, together with the fact that the sound after striking can be increased or decreased by the use of the pedal, opens up new possibilities of an organ-like nature. (One of the weak points of the instrument—perhaps the only serious one—is that these prolonged notes are only fully available in the bass, the treble strings coming to rest almost too soon; consequently, sustained chords lack brilliancy.

Double control of damping is fitted. First, there is the usual right pedal which, when released, causes immediate damping, and, when depressed, allows the string to vibrate naturally till it comes to rest; and, secondly, there is a special damper acting on all the strings, which, when "off," allows the vibration to continue to its maximum (over a minute in the bass, as already mentioned), and when "on" reduces it to a period comparable to that of a normal piano—this in order that existing piano music may be readily available for the new instrument.

As already stated, the left pedal controls the degree of amplification. When it is released, the loud speaker is out of action, and the instrument becomes the most charming spinet-harpsichord imaginable. When it is fully depressed, the volume is overwhelming, but here again there is a double control, an auxiliary knob reducing the maximum volume available to suit the room in which the instrument is to be used. This control is, of course, never changed except with a transfer to other surroundings, the pedal doing all the controlling during playing.

It may be added that the instrument also contains a complete wireless receiver and an electrical gramophone, and costs just a trifle less than the cheapest Bechstein grand. It works from the A.C. mains.



The "Neo Bechstein," seen from above. Note the array of small electro-magnets, each taking charge of five notes. The vibrations set up in the strings are transferred through the magnets to the amplifier, seen beneath the bass strings, and thence to a loud speaker.

Apparent Tone Variations

What was particularly interesting to the writer was to hear how much variation in the apparent tone-colour could be produced by combinations of touch and pedalling. The demonstrator was, of course, not only a first-class pianist, but had also specialised in the new instrument. He produced (in playing a set of very jolly variations written by himself) a series of effects ranging from the spinet through the piano to the organ, and thence to an excellent bassoon, trumpet, saxophone, and banjo, which would have appeared quite impossible with such limited means. It must be emphasised that no true tone-colour control exists, as, for example, in the case of the Trautonium.

NEWS of the WEEK

German Radio Census

GERMAN postmen engaged in collecting quarterly wireless licence fees on January 1st were instructed to question listeners concerning the type of set in use.

No More Park Wireless

NEWPORT Town Council has decided not to replace or maintain existing wireless sets in the three local parks. The cost for the ensuing year was estimated at £400.

Zagreb Joins the Movement

THE latest recruit to the higher power movement is Zagreb, Yugo-Slavia, which will install a 15-kW. transmitter this year to replace the existing 0.75-kW. equipment.

Roumanian Radio Ban

"HASTEN your Roumanian radio deliveries" is good advice to the British manufacturer in view of the latest list of goods which the Government in Bucharest intends to place under a quota. Telephone and wireless accessories figure prominently.

Mutual Interference?

THE path of true love, or peace, is not running smooth in the case of the new League of Nations transmitter at Prangins. According to Japanese testimony the very first messages intended to cultivate world-wide friendship were deliberately jammed by the Chinese station at Anching-fu. On the other hand, certain Chinese journals accuse the Japanese of "organised interference" with the transmission.

The Heaviside Layer is considered to be above suspicion.

The Ascending Curve

ON December 31st 5,262,953 licences had been issued by the Post Office, an increase of 140,000 over the previous month. During November 381 persons were prosecuted for not having licences—an easy record.

Another Means Test?

"I VENTURE to suggest that wireless licences should be purchased by getting 6d. or 1s. stamps at the Post Office until the ten shillings has been paid, the owner being allowed to operate his set on the first payment."—Correspondent in the *Birmingham Evening Despatch*.

Anything but That

A DISTINGUISHED-LOOKING gentleman walked into a Paris radio shop the other day and asked to be supplied with "a sensitive, pure, and selective receiver giving good loud-speaker reception from all European stations."

The dealer recommended the latest model of the X . . . Establishment.

"Not that," whispered the customer with a furtive glance round, "I am the manager of that concern."

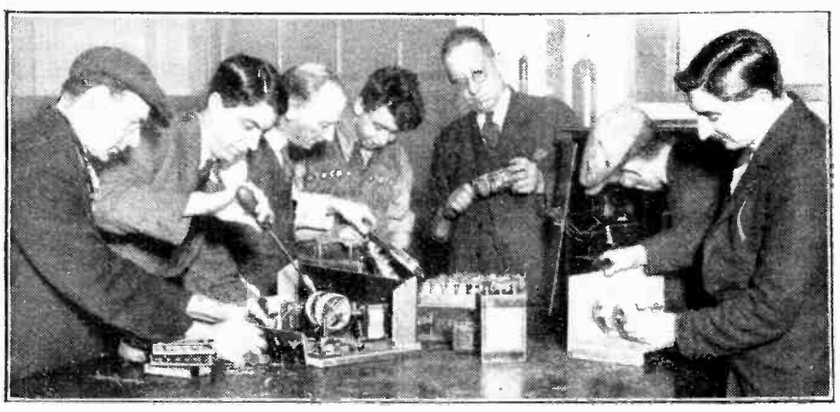
J'Accuse . . .

SO many complaints of man-made static have been received by the Danish Post Office since the Anti-Interference Act became law last year that the authorities have issued a new decree stipulating that the names and addresses of suspects must *each* be accompanied by a deposit of ten crowns. The sum is returnable if the complaint is justified.

Two thousand prosecutions have already been instituted, but the new decree seems to have stemmed the flood. Persons harbouring grudges against neighbours must now adopt other means of annoyance.

A Gaucherie

A FRENCH delegate, returned from the Madrid Radio Conference, has "dropped a brick" by declaring that the Spanish Government "treated us royally."



UNEMPLOYED AS SET BUILDERS. The local workless at Eastbourne can now attend wireless construction classes specially organised for their benefit. The photograph shows a group of men eagerly following the directions of their instructor.

Reunion of R.F.C. Radio Operators

THE fourth Annual General Meeting of R.F.C./R.A.F. Wireless Operators' Old Comrades' Association is to be held on February 14th next. Full particulars are obtainable from the Hon. Sec., Mr. R. McHugo, 16, Glennie Road, West Norwood, London, S.E.27.

Current Events in Brief Review

How Quartz Vibrates

AT a meeting of the Wireless Section of the Institution of Electrical Engineers on Wednesday next, February 1st, at 6 p.m., Mr. E. H. Rayner, M.A., Sc.D., will lecture on "The Researches of the late Dr. D. W. Dye on the Vibrations of Quartz."

A Royal Record

MANY listeners at home and abroad who heard, or failed to hear, the Christmas Day broadcast by H.M. The King will be interested in the permanent memento which has been prepared by "His Master's Voice" in the form of a gramophone record. All profits from the sale of the record, which is numbered R.B.S.4359, are being devoted to the British "Wireless for the Blind" Fund.

Radio-operated Clocks

A SYSTEM of operating clocks by radio waves broadcast from a central station has been patented by Clyde F. McCann, of San Francisco, to whom the U.S. Patent Office has issued Letters Patent No. 1,881,818. It is claimed that this system, utilising Hertzian waves transmitted from a central station having a master control clock, can hold all other clocks adequately equipped within its reception range.

Really Loud Speakers

THE twelve loud speakers now in use at the White City Stadium greyhound racing track are built behind an unusual flare which is designed so that the sound, after it has travelled a certain distance, is controlled and focused into a beam, with the result that the sound is kept at practically constant strength.

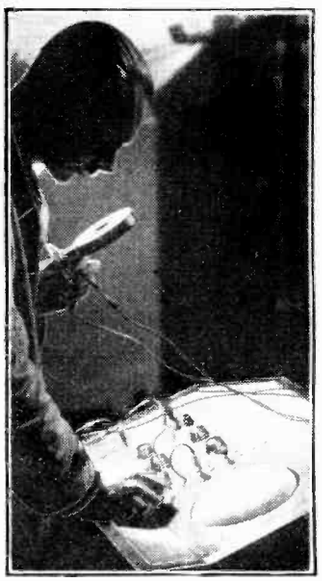
Pamphonic Reproducers, Ltd., the builders of the amplifier, claim that almost perfect "straight-line" amplification is possible over a range between 32 and 5,000 cycles. The anode voltage of the valves is 1,500, and they are biased with 60 volts. The set has an undistorted output of 500 watts.

Luxembourg at Last?

SO much has been written and talked about *Radio Luxembourg* that one hesitates to accept the report that at last the station is to begin regular transmissions, that a studio is being erected in the Villa Louvigny, and that an orchestra of thirty musicians has been engaged. M. Jehan Marcin, runs the report, is the new station director. *Radio Luxembourg* has an aerial power of 200 kW.

Sunspot Minimum Now

SIX amateur transmitters, comprising the experimental Group 10A of the R.S.G.B., have just been successful in receiving American amateur signals on the 1,750-k.c. band—the lowest frequency



COLOURED TELEVISION. The Loewe Company has produced a cathode-ray tube, the "flat" portion of which is seen in the panel, for two independent rays. By its use coloured television is possible.

channel assigned to amateurs. Convinced that, with the approach of the sunspot minimum, conditions would show a remarkable improvement on this frequency band, they maintained watch in the early hours of the morning for ten days, and were rewarded by hearing three U.S. stations as far west as Pennsylvania. One transmitter at Cape Cod came over with remarkable consistency, and, when his confirmation was received, the British participants learned with great astonishment that the operator was using two aerials, each 280ft. long and running at right angles. The input used was 200 watts.

Finding the Best "Earth"

INVESTIGATIONS on the electrical properties of soil carried out at the National Physical Laboratory on behalf of the Radio Research Board were described in a paper read before the Royal Society on Thursday, January 19th, by Dr. R. L. Smith-Rose.

The experiments consisted in measuring the electrical resistance of samples of soil from different sites under conditions corresponding with those met with in radio communication. The results of the experiments showed that, while dry soil is a poor conductor, the conducting power is increased more than one thousand times when water is added to bring its moisture content up to the value commonly met with in gardens.

More About The STATION FINDER

The Finer Points of Adjustment and Operation

By H. F. SMITH

What it is

A simple, accurate, and effective form of wavemeter—but, unlike other wavemeters, with an indicating scale marked directly in station settings. Instant identification is thus obtained without intermediate processes.

How it works

The Station Finder is connected in the aerial lead-in wire. It identifies the source of incoming signals by sharply reducing their strength as the dial is rotated through the corresponding setting. The station name is then read directly from an indicating disc.

(Full details in "The Wireless World," January 13th.)

IT seems necessary to begin by stating unequivocally that, so far as the tuning condenser of the Station Finder is concerned, there is no known alternative to the particular make of component with which the device was originally calibrated; any other condenser, even though of equally robust construction and ostensibly with the same law, is bound to be so different in characteristic that the printed station scale will become almost useless. Similarly, the tuning coil is an important "key" component; it would not be impossible to make a duplicate with the same inductance value, or to correct, by a more or less laborious process, any discrepancies in the winding of a home-made coil, but it is strongly advised that the specified component should be used.

Another misconception that should

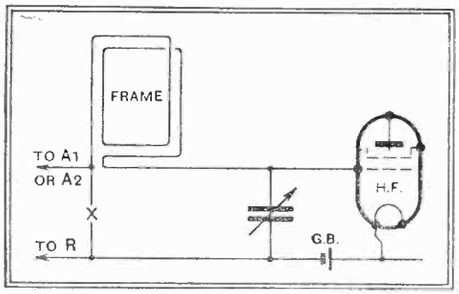


Fig. 1.—Operating the Station Finder with a frame-aerial receiver. External connections to the plug sockets are indicated.

perhaps be corrected is that, when once initial adjustments have been made, the Station Finder will read accurately with any aerial and any receiver. This is not necessarily so, as there are bound to be differences in stray capacity which will affect calibration, but they will probably not be serious enough to cause ambiguity or to necessitate readjustment.

Although designed for "open aerial" sets, the Station Finder can be operated with self-contained frame-aerial receivers by breaking into the frame circuit at the point marked X in Fig. 1. This procedure is satisfactory for all sets except those with ganged tuning; for these, the addition of a buzzer, as described later in this article, is almost always necessary.

Coupling Adjustments

In order to obtain the sharpest and most definite readings, it is wise to work with the loosest possible coupling between the Station Finder circuit and the receiver. At the lower end of the wave-range scale it may be possible to obtain sufficient coupling by inserting the aerial plug into socket A 1 and joining the receiver aerial terminal to socket A 2, thus leaving only two turns in the coupling coil.

Failure to obtain sufficiently well-marked absorption (or reduction of signal strength) as the Station Finder is rotated through the "in-tune" position may be due to heavy losses in the aerial circuit; such defects are shown up pitilessly by the method employed. Here, again, the difficulty may be overcome by fitting a buzzer, or, very much better, by improving the aerial system. Generally speaking, absorption will be most marked when listening to signals that are fairly weak, either naturally or through the effect of applying the volume control while identification is being carried out. There is no real need for the transmitter to be modulating, and, indeed, very accurate measurements can often be made on the unmodulated carrier wave; the background noises superimposed on it will be reduced in strength as the indicator circuit is brought into tune. Readings are apt

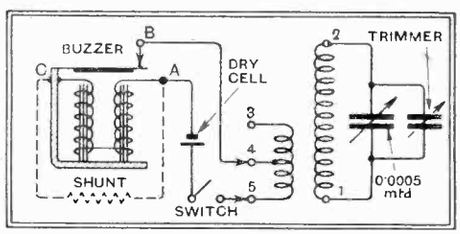


Fig. 2.—How to convert the Station Finder into a radiating meter, suitable for operation with any type of set, by the addition of a buzzer.

to be a little misleading if the receiver is on the point of self-oscillation, and so too much reaction should not be employed.

A detector anode current meter is a desirable, but by no means essential, aid to the taking of readings or to initial calibration. When grid leak detection is employed in the receiver, current will fall when the receiver is tuned to a signal; as the Station Finder is brought into tune with the same wavelength, current will again rise, maximum deflection being obtained at the point of resonance. Exactly opposite effects take place in sets with anode bend detection.

A Radiating Station Finder

As already stated, the original Station Finder will usually fail to work with sets in which the aerial is directly coupled to

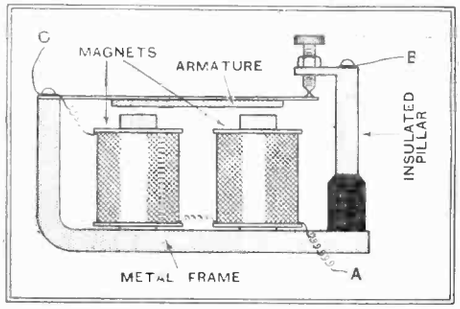


Fig. 3.—Constructional details of a typical buzzer. Lettering of the terminal points corresponds with Fig. 2.

the high-potential end of the input coil through a very small condenser (something between 20 and 50 micro-microfarads). The most satisfactory way of making the device suitable for operation with such sets, and also those with automatic volume control, is to convert it into a radiating wavemeter by the addition of a buzzer, on-off switch, and dry cell in the manner shown in Fig. 2. Probably the best buzzers to use are those which were designed for use in Service wavemeters, and of which a large number are still available at a cost of some three or four shillings. Among other firms supplying these appliances are the Grafton Electric Co., 54, Grafton Street, London,

More About the Station Finder—

W.1, and Electradix Radios, 218, Upper Thames Street, London, E.C.4.

A fairly small dry cell, such as the Siemens "S" size, will be suitable in most cases, as the current consumption is not heavy, and, moreover, is intermittent. As for the switch, any available component of the on-off type will do, and it may be mounted on the top right-hand corner of the panel; the other components may be secured inside the cabinet.

A 7in engraved ivorine dial for the Station Finder is available from the Publishers at a cost of 2/-, post free.

Buzzers differ in their construction, although all are identical in principle. The simplified sketch given in Fig. 3 will make clear the construction and connections of these devices; terminal points are lettered to correspond with Fig. 3. It should be noted that, in order to eliminate sparking at the vibrating contact, a non-inductive resistance shunt must be connected across the buzzer coil or coils. This shunt may have an ohmic value roughly equal to that of the windings themselves; the type of buzzer mentioned above is usually wound to 25 ohms, and a 20-ohm resistance, preferably of the carbon or metallised type, may be used.

When a buzzer is employed, the procedure for making initial adjustments, and afterwards for identifying stations, is rather different from that already described. The set is tuned to a known transmission at about 250 metres, and the indicator dial is set accurately to register the name of that station; the buzzer is then put into operation, and the trimming condenser is adjusted until the local radiation is heard at maximum strength from the loud speaker. To identify a station, the indicator dial is rotated until buzzer signals are of maximum loudness, and the name is then read directly from the scale.

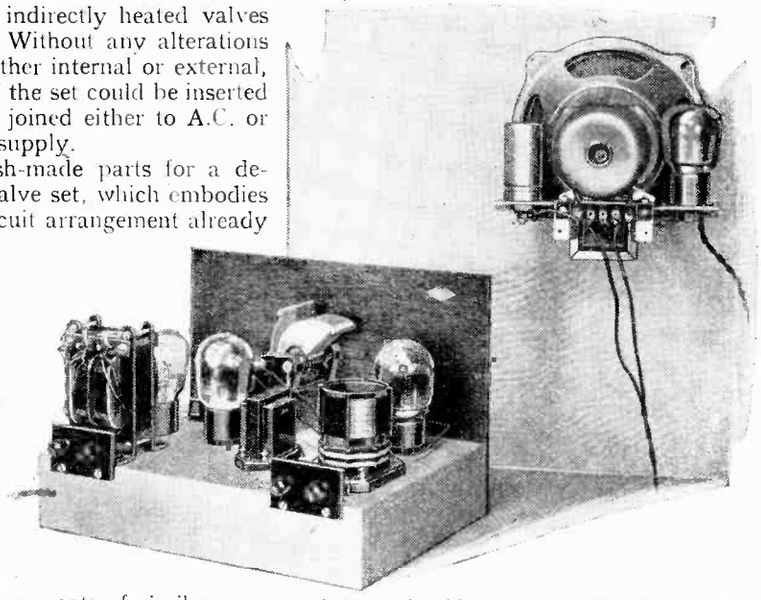
For operation with a buzzer, there is no direct connection to the receiver; it will generally be best to place the Station Finder at a distance of a foot or two from the aerial lead-in wire. As a rule, the buzzer, battery, and switch should be joined in series across the primary terminals of the coil which are marked 3 and 4; when dealing with less sensitive sets, terminals No. 4 and 5 may be used.

INTERCHANGEABLE FOR A.C. OR D.C.

A New Kit of Parts

IN *The Wireless World* of June 15th a description was published of a "Universal" A.C.-D.C. set, in which Ostar indirectly heated valves were employed. Without any alterations to the receiver, either internal or external, the power-plug of the set could be inserted at will in sockets joined either to A.C. or D.C. sources of supply.

A kit of British-made parts for a detector-L.F. two-valve set, which embodies essentially the circuit arrangement already described, has now been produced by Eugene Forbat, Nivalight, Ltd., 1, Rosebery Avenue, London, E.C.1. Subjected to test on both A.C. and D.C. supplies, the receiver compared well with more conventional arrangements of similar pretensions. The background when working on D.C. was particularly quiet, and, on A.C., hum was not above the average level.



A two-valve kit set, with indirectly heated high-voltage valves, and a field supply kit for obtaining energising current from A.C. mains.

Field Supply.

The complete kit of parts, including two receiver valves and a rectifier, costs £6 10s.

Economy in maintenance cost, particularly on D.C. supplies, is a strong point, as total consumption of energy amounted to little over 25 watts—much less than that of the average domestic electric lamp.

For supplying energising current to the field winding of a moving-coil loud speaker, the directly heated high-voltage Ostar rectifying valves are particularly suitable. Their applications in this direction were described in our issue of March 23rd. A kit of parts at the price of £2 5s., including the valve, is now available for feeding standard field windings; smoothing is effected by an electrolytic condenser of the aqueous type.

DISTANT RECEPTION NOTES

BIG changes are imminent in French broadcasting affairs, especially in the Paris area. It is reported on the one hand that the Eiffel Tower will shortly go out of business as a broadcasting station, rising to a higher wavelength and confining itself to time signals, weather reports, and so on. On the other hand, Radio-Paris, at present the property of a company, is to be taken over by the Government.

There seems to be no justification for the retention of either Radio LL or Radio Vitus. They are both quite small stations, but the amount of interference that they cause is considerable. At present neither is working on anything like its proper wavelength—not that either of them often does.

The Russian broadcasting scheme now has six stations of 100 kilowatts at work. Four of these are situated in Moscow, the others being at Leningrad and Novosibirsk.

A good deal of confusion arises from time to time over the Hilversum and Huizen programmes. Actually, there are two transmitting stations, Huizen on 1,875 metres, and Hilversum on 296.1 metres, and four broadcasting associations. Of the latter one, the Labour Radio Society (VARA) is a political body; two, the Catholic Radio Society (KRO), and the Christian Radio Society (NCRV) are religious associations, and the last, the General Broadcasting Association (AVRO), is something which corresponds more or less—very much less than more—to the B.B.C. The VARA and AVRO nominally share the Hilversum programmes, whilst the KRO and the NCRV parcel out those of Huizen between them.

So far so good, but now a complication arises. The long-wave Huizen has a much better service area than the shorter-wave Hilversum, and to ensure that fair is fair a change-over is made every three months. At the present time Huizen is Hilversum, sending out the VARA and AVRO programmes on 1,875 metres, whilst Hilversum is Huizen, transmitting those of the KRO and the NCRV on 296.1 metres.

Luxembourg Testing

Though refused, one understands, a wavelength by the Madrid Conference, Luxembourg is still conducting tests during daylight hours on a little below 1,280 metres. Next to one's local this must be the world's easiest station to pick up, and the heterodynes caused are almost unbelievable.

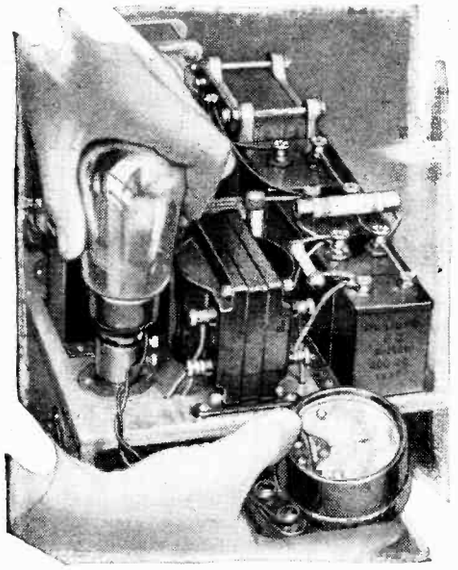
The best stations at the moment on the long waves are Huizen (which, of course, is temporarily Hilversum!), Zeesen, Warsaw, and Oslo. Both Motala and Kalundborg are distinctly off colour.

On the medium waveband the choice is still a very wide one, though heterodynes spoil a good many transmissions. The worst crop of these that I can ever remember is to be found now between 358 and 372 metres, where every station appears to be heterodyning or jamming every other. The main cause of the trouble is the aforementioned Radio LL, which is causing station after station to wander in self-defence from its wavelength. The stations best worth attention are Munich, the two Brussels stations, Langenberg, Rome, Katowice, Leipzig, Toulouse, Strasbourg, the Poste Parisien, Breslau, Bordeaux, Hilversum, Heilsberg, Trieste, Nurnberg, and Fécamp.

D. EXER.

Practical HINTS AND TIPS

AIDS TO BETTER RECEPTION



Wiring of D.C. Sets

WHEN building a mains-operated receiver it is usual to take a good deal of care with the arrangement of connecting leads carrying "raw" A.C. current; the "go" and "return" leads are generally twisted together, and they are spaced as widely as possible from such danger points as detector-grid circuits, etc.

In dealing with D.C. mains sets it is sometimes forgotten that almost equal care should be taken, particularly with regard to the heater wiring and the mains leads connected to the on-off switch, at any rate, if this component be mounted on the front panel.

Electrostatic pick-up in the detector circuit—not forgetting the second detector of superheterodynes—should again be guarded against.

Testing by Touch

ALMOST every user of a wireless set will have observed that various effects become evident if certain parts of the receiver be touched with the finger while it is in operation. It is sometimes held that rough-and-ready tests may be carried out in this manner, but it is by no means easy to draw a logical conclusion from the effects that may be observed. One result of touching the point in the receiver is to connect a resistance of high but rather uncertain value between that point and earth. Another effect, which in nearly every case is much more important, is to add a capacity of similarly undefined value between the same point and earth. Further, body capacity may act as an unwanted coupling between circuits, and so may produce instability.

By touching the high-potential end of the grid circuit, it is generally reassuring to find that signal strength is decreased, thus indicating that the tuning of the circuit has been disturbed. It is possible that on touching the high-potential end of one of the tuned circuits of a ganged receiver, signals will become stronger. This effect conveys the warning that in all probability the circuit is out of alignment with the other, and has been artificially brought into tune by the addition of body capacity.

A complicating factor, which shows the dangers of forming too hasty conclusions, is due to the "aerial" effect of the body. To avoid excessively loud signals, tests are often made with no aerial, or with a very short aerial, and in such cases the signal "pick up" of the body may overshadow the effect of its capacity in detuning the circuit.

Long-range Sets with Q.P.P.

IT will be fairly obvious that the use of the quiescent push-pull system, which offers extraordinary advantages in battery-operated sets, is by no means confined to simple det.-L.F. outfits of limited range. It works just as satisfactorily when the detector valve is preceded by one or two stages of H.F. amplification.

Those who propose to employ this efficient and economical system would be well advised to adhere to the detector-output arrangements of the "Quiescent Push-pull Two" described last week, but with regard to an H.F. amplifier to precede it, there is no reason why conventional practice should not be followed, and existing components of standard design may be employed. For the benefit of those working on these lines the circuit diagram given in Fig. 1 has been prepared; it shows a satisfactory form of tuning system and intervalve coupling to work with the set in question.

Probably the only detail that requires explanation is the method of obtaining variable bias for the H.F. valve. Although there are other ways of doing it, the method shown is probably as convenient and economical as any other. A second potentiometer for controlling H.F. grid voltage is merely shunted across the potentiometer already provided for close adjustment of output-valve bias.

In order to maintain the proper load on the grid-bias battery it is advisable to increase the value of the original potentiometer R5 from 25,000 to 50,000 ohms, and the added "H.F." potentiometer should have the same value.

In the diagram the components associated with the detector-L.F. circuits have been assigned their original reference lettering; suggested values for the additional components are also shown. Coupling condensers for the input band-pass filter are marked CC1 and CC2; if the "double capacity" method of coupling be employed these should have the capacities recommended by the makers of the coils.

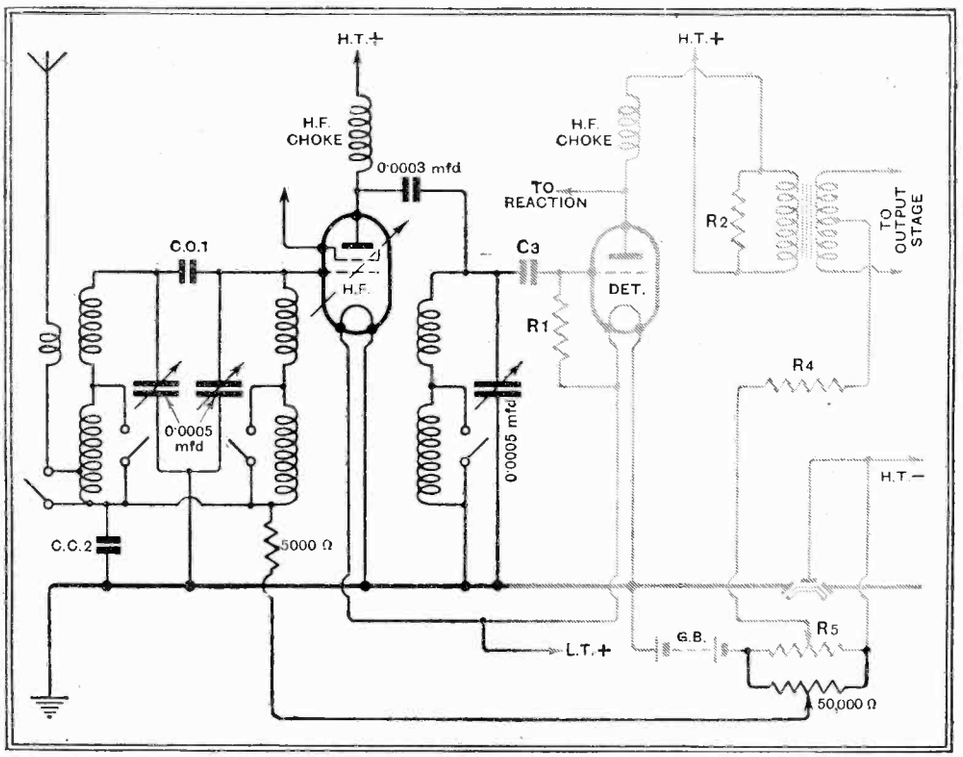


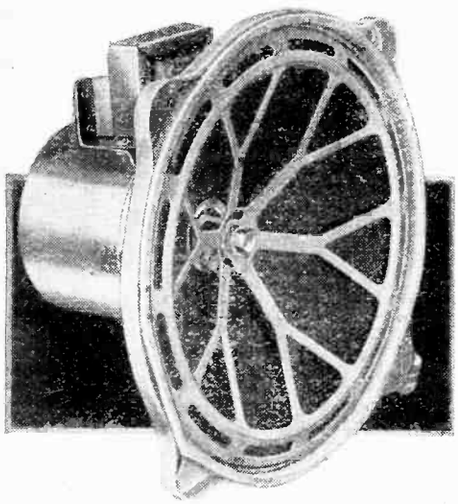
Fig. 1.—Adding an H.F. stage to the "Quiescent Push-pull Two."

LABORATORY TESTS

MAGNAVOX "MAGNA" LOUD SPEAKER

THAT the field strength in a moving-coil loud speaker is one of the most important factors affecting the sensitivity and acoustic efficiency is well known. It is not generally appreciated, however, that an increase in the magnetic field is also capable of effecting a marked improvement in the quality of reproduction. This is due to the fact that a strong magnetic field, in conjunction with a closed circuit moving coil resistance of low value, introduces damping which considerably reduces the effects of any mechanical resonance which may be present in the diaphragm assembly.

In the type DC142 "Magna" loud speaker tested this effect can be convincingly demonstrated by lightly tapping the diaphragm with a pencil and at the same time switching the field current on and off.



The new Magnavox "Magna" type loud speaker which incorporates an exceptionally generous magnetic circuit.

With the field off, the natural period of the diaphragm at about 90 to 100 cycles can be distinctly heard, but completely disappears when the field current is switched on.

The general quality of reproduction compares very favourably with loud speakers of similar type employing a lower flux density in the field. There is no sharply defined bass resonance, and the bass output, which is of a slightly higher order than that in the middle register, is spread over a comparatively wide band from 75 to 250 cycles. There is another region of increased output between 2,200 and 4,000 cycles, and the extreme top between 4,500 and 8,000 cycles is unusually good, being comparable in strength with the middle register. The reproduction of transients is crisp, and the quality of speech is decidedly above the average.

It is, however, in the matter of sensitivity that the "Magna" loud speaker excels. The general level of acoustic output for a given electrical input is fully six decibels above the average medium-sized energised moving coil. In actual fact the efficiency, as far as our tests are concerned, has only been equalled by one or two horn-type, moving-coil loud speakers in which the directional effect of the horn plays a considerable part.

The "Magna" series of loud speakers are made in two types with 7in. and 8¾in. diaphragms. The DC142 tested is of the latter size, and costs £3 7s. 6d. complete with output transformer. The makers are Magnavox (Great Britain), Ltd., 89, Kingsway, London, W.C.2.

NEW RADIO PRODUCTS REVIEWED

LOTUS COMPONENTS TESTED

ALTHOUGH specimens of all the latest Lotus components have been sent in for examination, only a few can be dealt with here in view of the extensiveness of the range. Of the various L.F. transformers made, the Type 2 was chosen for test, as this is a medium-priced model made in 1 : 3 and 1 : 5 ratios, and costs 7s. 6d. With the 1 : 3 ratio model connected in the anode circuit a valve of 10,000 ohms A.C. resistance and with a current of 1.5 mA. flowing the amplification is maintained at a satisfactory level from 200 cycles up to 6,500 cycles. The maximum amplification is attained at 3,500 cycles, when there appears a slight peak equivalent to an increase of 5 decibels above the general level measured at 1,000 cycles. The D.C. resistance of the primary winding is 1,000 ohms, and its inductance at 50 cycles with no D.C. flowing is 32.5 henrys.

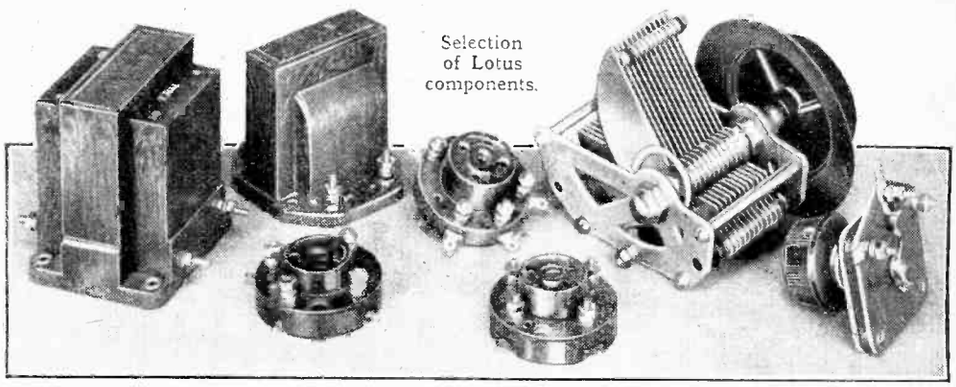
The D.C.1 output choke, which is rated at 20 henrys, has a resistance of 750 ohms, and will carry up to 20 mA. of D.C. This model is more suitable, however, for use in small sets and eliminators where the normal working current does not exceed some 12 mA. under which conditions the rated value of 20 henrys was obtained. With no D.C. flowing, the inductance was 83 henrys, but this fell to 25 henrys with a D.C. current of 8 mA. passing through the choke.

There is a wide selection of differential condensers available. One model, known as the Miniature Type, is made in values of 0.00015 and 0.00035 mfd., and the price is 3s. These are of the solid dielectric type, and are ideal for use in reaction circuits, for their minimum capacities are very low indeed. The specimen tested showed a minimum capacity of 5.5 m-mfds. on each side, the maximum capacities being 0.000237 mfd. and 0.000238 mfd. respectively. Another style fitted with stout brass vanes and made in 0.00013 mfd. and 0.00034 mfd. costs 4s. 6d.

The Slow Motion Log Condenser is made almost entirely from aluminium, and, since the price complete with knob and dial is but 6s. 6d., it should prove of interest to those concerned with the construction of an inexpensive receiver. Two sizes are available, viz., 0.0003 mfd. and 0.0005 mfd. The minimum and maximum capacities of a 0.0005 mfd. specimen were found to be 16.5 m-mfds. and 0.000475 mfd. respectively.

Three types of valve holders are now made; the cheapest model is the V.H.K. It is an anti-microphonic four-pin valve holder, and costs 6d. The rigid type, which is for A.C. valves, is available with or without terminals, the prices being 9d. and 10d. each respectively. A miniature anti-microphonic model measuring 1⅛in. in diameter costs 1s. with or without terminals.

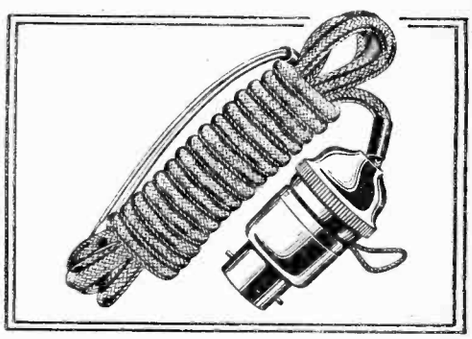
The makers are Lotus Radio, Ltd., Mill Lane, Old Swan, Liverpool.



Selection of Lotus components.

HARBROS MAINS LEADS

A SILK-BRAIDED mains lead ready for fitting to a mains receiver and terminating in a universal lamp holder and two-pin plug adaptor is now obtainable from Hart Bros. Electrical Manufacturing Co., Ltd., Queensway, Ponders End, Middlesex. There are two styles available, the one consists of a single pair of conductors, while the other has three wires, one of which is intended to be used as a mains aerial. There is no direct connection between the aerial wire and the mains, the capacity between the leads providing adequate coupling for most purposes.



Harbros silk-covered mains lead fitted with universal adaptor.

The single-pair lead costs 2s. 9d. in 8ft. lengths and 3s. 6d. in 12ft. lengths, while the price of the three-wire style is 3d. extra in both cases.

CATALOGUES RECEIVED

British General Manufacturing Co., Ltd., Brockley Works, Tyrwhitt Road, London, S.E.4.—Fifteen-page catalogue describing British General receivers and components.

The British Ebonite Co., Ltd., Nightingale Road, Hanwell, London, W.7.—Illustrated handbook of coils, wound on Becol formers, also circuit diagrams showing their application.

BROADCAST BREVITIES

By Our Special Correspondent

Inside the Organ

I HAVE just been savouring existence inside the new £10,000 organ at Broadcasting House. Three experts have spent many working days in this cramped cubby-hole, and will continue to do so for the next three weeks, by which time, so they tell me, the organ should be playable.

Compression Marvels

The whole thing is a miracle of compression. "We have never had quite such a job before," one of the organ builders told me. "In cinemas, we often have to make the most of a small space, but we haven't so much to cram into it. This time the organ is a really big one. However, the whole job has been very carefully worked out and the results will be good."

Like a Cave

Impossible at present to judge from appearances whether the results will be good, bad or indifferent, for all that can be seen are pipes and conduits clustered like stalactites and stalagmites in a cave. There are no bellows, as wind will be supplied direct from the electric fan to the wind chests at automatically regulated pressure.

"Cinema Organ" to Order

One thing I can and will reveal, namely, that this organ will be able to beat any cinema organ at its own game if the performer so wishes. Within the instrument are "effects"—drums, triangle, cymbals, glockenspiel, and other contraptions—which would make an ordinary organ enthusiast go queasy.

Happily, however, there is ample diapason material to provide the authentic organ tone when required.

A Suggested Time Switch

A correspondent writes suggesting that the installation of the new organ is a good opportunity for the introduction of "a special time switch which would function when the player had (1) used the tremulant for two consecutive minutes or (2) used a nanny goat stop with tremulant for one minute, or (3) forgotten he wasn't blowing a nigger organ with the swell pedals. By means of the time switch all nanny goats, vox infantas, tremulants, and celestes would be immediately drawn in and securely locked for two hours."

U.S. Calls Fleet Street

"HELLO, Fleet Street," is the title of a programme which National and Regional listeners will hear to-morrow evening, January 28th. The programme will originate in one of the New York studios of the Columbia Broadcasting System, who are presenting it as a final summing up in a series of round-table discussions which they have recently broadcast under the title of "America's Grub Street Speaks." The participants in the discussion on January 28th will include Mr. Richard Roy Smith, a New York publisher of note, on the subject of English and American Publishing; Mr. George Jean Nathan, editor, author and critic, on International Relationships among Authors; Mr. Ernest Boyd, the author, on International Criticism; and Mr. Theodore Dreiser on World Affairs and Literature.

A Mystery: B.B.C. and the Test Match

THE B.B.C. "gets it in the neck" so often that I rejoice when an occasion arises to defend the Corporation at the expense of the foreigner. Several readers have asked me why the B.B.C. account of the Test Match at Adelaide was so indistinct and upset by atmospherics as compared with the crystal clear enunciation of Alan Fairfax, picked up and relayed by Poste Parisien.

The Explanation

The explanation is simple. Poste Parisien, despite appearances, was not giving listeners a direct first-hand account from the Adelaide cricket ground. The "story" was cabled and retailed at the Poste Parisien microphone. On the other hand, the B.B.C. account was heard from Adelaide direct, being transmitted over the Post Office Australia-England beam system. Which method is more popular with listeners?

BEHIND THE SCENES. B.B.C. engineers checking amplifier performance behind one of the panels in the Control Room at Broadcasting House.

Talk by Gangster?

EVERYONE at Broadcasting House, including Mr. Charles Siepmann, Director of Talks, is asking about the "prominent American gangster" who is to defend racketeering in a forthcoming broadcast talk. No one knows of such a fixture, yet Colonel Moore-Brabazon, M.P., has sought the Speaker's permission to ask the Home Secretary whether, in his opinion, such a broadcast is for the public weal.

Is the Colonel thinking of those desperadoes, Haver and Lee?

Roy Fox from the Kit Kat

AT least a temporary truce seems to hold sway between the B.B.C. and the General Theatres Corporation: indeed, to judge from certain circumstances, the two organisations are thoroughly good friends. Why else should the Kit Kat Club (which belongs to Gaumont British, which in turn is allied to the G.T.C.) undertake special structural alterations to enable Roy Fox to give of his best for broadcasting purposes?

By the way, this sparkling dance-band leader and his equally sparkling band are to be heard more frequently on the ether.

The Search for Variety

If the B.B.C. ever hopes to form a vaudeville repertory company of its own it has received little encouragement from the recent crop of auditions. Some fifty aspirants are now being heard each week, and the B.B.C. feels hopeful if two out of fifty come within measurable distance of being "possibles."

Cynics in the Making

Views at headquarters are growing less sanguine on the question of the plentifulness of vaudeville talent in unexplored corners of this green and pleasant land. Apparently a spell of auditions has turned optimists into cynics.

Malcolm Frost Ill

HERE'S wishing a speedy recovery to Malcolm Frost, the B.B.C.'s "Empire Ambassador," who has been checked on his world tour by an attack of malaria at Cape Town. This puts him at least four weeks behind schedule, for he should have been in India by now.

Mr. Frost is engaged in distributing the special records of B.B.C. programmes for rebroadcasting from local stations up and down the Empire.

A Plea for Poetry

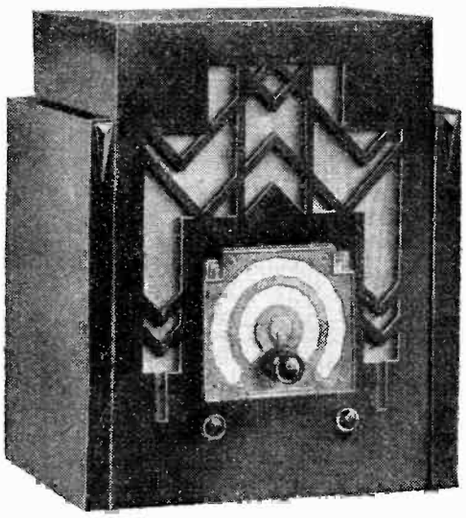
THE B.B.C. is constantly searching for new talent in music; the Corporation's latest invitation is extended to poets. It wants the late five-minute readings at the end of each night's programme from the studio to be representative of the loveliest poetry not only of the past, but of the present, and it invites every listener to submit by February 28th poems from which a selection will be made. Those selected will be read at the microphone during the late readings in the month of April.

Brevity a Merit

Mr. Walter de la Mare and Mr. Eddie Marsh, editor of the volumes of "Georgian Poetry" will act as judges of the poetry submitted.

Why Engineers See Red.

EXTRACT from postbag of B.B.C. Technical Correspondence Section:—"After midday at night the air is deadly silent."



Six-Sixty Type 3-32 Chassiset

A Battery-operated Receiver with Exceptional Range

ONLY two or three years ago the opinion was generally held that a three-valve H.F.-det.-L.F. receiver was not really sensitive enough for consistent long-range reception, although the better examples were admitted to be capable of receiving foreign stations when conditions were good. Since that time we have modified our views; many stations have increased their power, and, more important still, sets generally have become vastly more sensitive and selective.

In the Six-Sixty Chassiset we have something more than just another example of modern tendencies in battery set design; judged by any standard it is exceptionally sensitive, and, what is equally important, has enough selectivity to enable full use to be made of its range.

Although the essential circuit arrangement is conventional, there are many departures from standard practice; the underlying aim of the designers seems to have been to simplify operation wherever possible.

Double-acting Volume Control

At the aerial end there is a band-pass filter with a link-circuit coupling. The choke-fed tuned-grid system is employed in the H.F. stage, and the detector operates on the grid leak principle. A directly connected transformer is employed in the L.F. stage, and another transformer serves to link the high-efficiency output pentode (a Six-Sixty 220 PEN) to a moving-coil loud speaker, which, as this is a battery set, is, of course, of the permanent-magnet type. In the grid circuit of the pentode an H.F. stopping resistance is inserted.

One of the most interesting circuit details is to be found in the combined volume-reaction control, which is effected by means of a variable resistance shunt across the aerial circuit in combination with the reaction condenser. Both these components are mounted on a common spindle and are controlled by a single knob; as the resistance is progressively increased in value, reaction feed-back between anode and grid circuits of the detector is similarly increased. It should be noted that matters have been ingeniously arranged for the same variable resistance to act as a gramophone volume control. For this purpose it becomes the variable limb of a potentiometer when the pick-up is thrown into circuit; the second limb consists of a fixed resistance.

Automatic bias voltage for the output valve is developed across a resistance in the negative H.T. lead in the usual manner; the inclusion of this refinement is to be commended, as the non-technical user, without access to measuring instruments, can rest assured that, when H.T. voltage falls with increasing age of the battery, a commensurate reduction in bias voltage will take place automatically, and so the best possible quality of reproduction will be maintained under all conditions without the need for adjustments.

Provision has wisely been made for compensating for the varying capacities of different aerial-earth systems, with the object of maintaining full sensitivity and selectivity under all conditions. This adjustment, which need only be carried out when the set is first installed, is effected by a semi-variable aerial series condenser, of which the controlling screw projects through the back of the chassis in a position where it is sufficiently accessible for the purpose.

A clue to the reason for the exceptional sensitivity of the Six-Sixty set is found in the three tuning coils, which are screened in copper pots of dimensions rather greater than usual. The medium-wave windings are of stranded litz wire, and have obviously been proportioned for maximum efficiency.

Another constructional detail worthy of special mention is the large indicating dial, which, in addition to carrying a scale marked in arbitrary units, is station-calibrated on both medium and long wave-bands. The dial is illuminated from the back by means of pilot lamps mounted in a container which revolves with the condenser drive mechanism; narrow beams of light concentrated through slits in the container act as index marks, which are automatically transferred by operation of the wave-range switch to the appropriate part of the scale. The pilot lamps are automatically switched on as soon as the set is put into operation, but, to avoid wastage of battery current, they may be switched off, as soon as the desired programme has been tuned in, by means of an extra switch which is built into the tuning-control knob.

As the necessary voltage-absorbing resistances for the various anode and screening-grid circuits are included in the receiver there are only two leads to the H.T. battery, and so the operation of fitting a replacement battery is greatly simplified. Another refinement is the provision of a safety fuse in the negative H.T. lead.

As already implied, the most impressive feature of the Six-Sixty receiver is its sensitivity. In this respect it will bear comparison with many mains-operated receivers with a similar circuit arrangement. Performance is particularly striking on the medium band, and sensitivity is maintained much better than usual towards the upper end of the wave-range scale. Although it might perhaps be a little more constant, reaction control works well, without roughness or overlap.

On the long waves, the range of the set is perhaps not quite so striking, but is relatively good when compared with the average standard. On both bands, selectivity is rather greater than one expects to obtain from a three-circuit set, which means that it is sufficient for all reasonable requirements.

Taking into account the fact that the total anode-current consumption, with an H.T. battery of 120 volts, amounts only to 8 or 9 milliamps., the volume obtainable is surprisingly high, which would indicate accurate matching in the output stage. But quality is at its best at a level slightly lower than that obtainable without running into obvious overloading.

FEATURES

General. *— A self-contained three-valve receiver for battery feed and for operation with an external aerial-earth system. Permanent-magnet moving-coil loud speaker. Provision for gramophone pick-up and external loud speaker.*

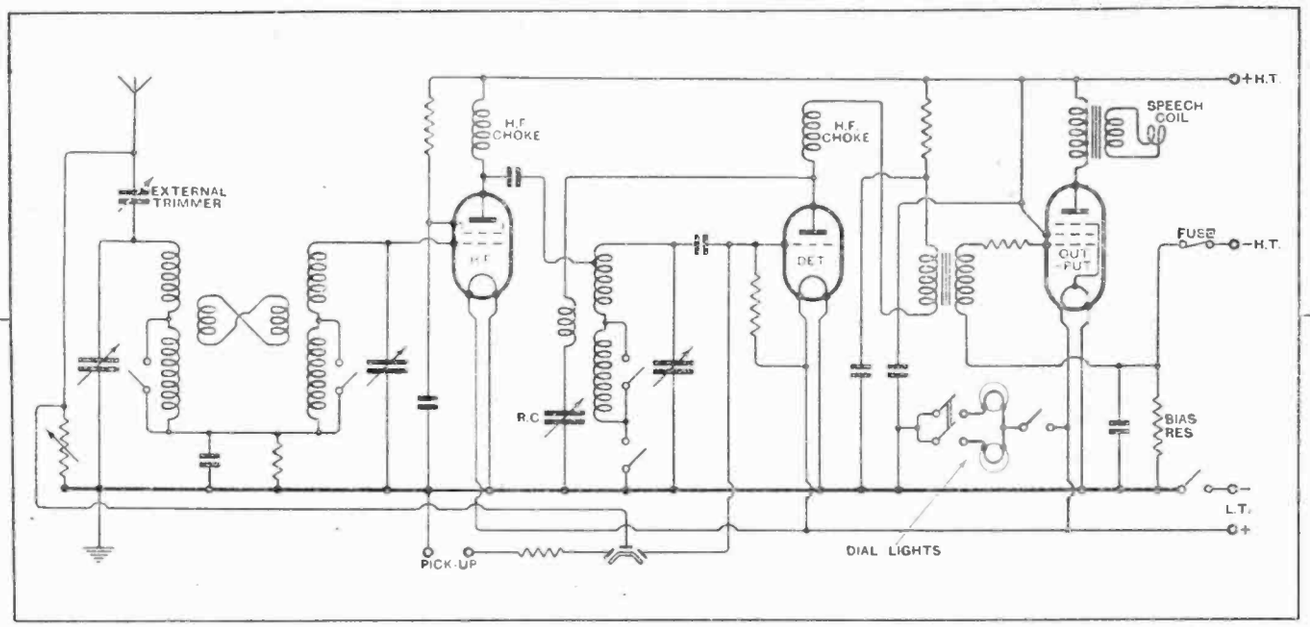
Circuit. *—Input filter, with "mixed" coupling. One tuned H.F. stage, parallel fed. Grid detector, transformer-coupled to pentode output valve. Transformer feed to loud speaker.*

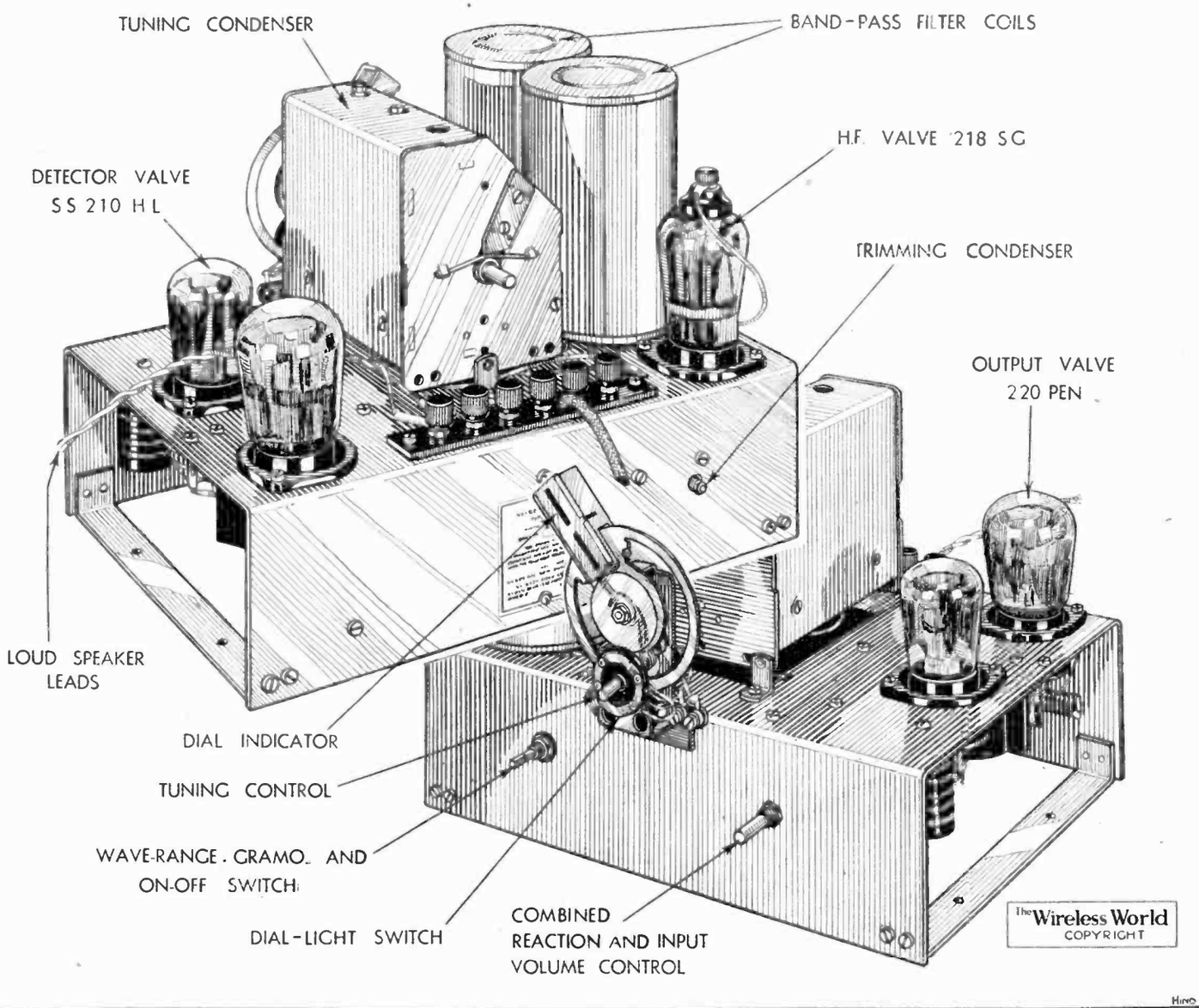
Controls. *—(1) Ganged tuning. (2) Combined on-off, wave-range and radio-gramophone switch. (3) Combined reaction and input volume control.*

Price. *—10 guineas, complete except for H.T. and L.T. batteries.*

Makers. *—Six-Sixty Radio Company, Ltd., 17 - 18, Rathbone Place, Oxford Street, London, W. 1.*

Modern Tendencies in Battery-set Design





Two views of the Six-Sixty Type 3-32 chassis. The dial lights are fitted inside a rotating carrier. Inset: Complete circuit diagram of the receiver.

Correspondence

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

What Does the Public Want?

THERE appears to be a good deal of evidence pointing to the existence of a huge misunderstanding in receiver design.

On the one hand, designers, reviewers, discussers, and critics almost invariably take it for granted that the most important function of a receiver (home or factory built) is the reception of foreign stations. It is judged and discussed from that angle, and the suggestion that there are some listeners who have no particular desire to receive programmes other than the two locals is met with cynical amusement.

On the other hand, my personal observation has failed to reveal one single listener who has any sustained interest in hearing distant programmes. There are those who take a butterfly tour of the Continent, not to listen seriously to the programmes, but for the fun of it, just as a motorist may open out a sports car even though he has no desire to get to any particular place quickly. But I have never come across a person who makes a practice of listening continuously to foreign programmes.

There are many things that can be said in explanation, confirmation, or refutation of these conflicting situations. I may have struck an exceptional patch of the genus Listener, and there may be no real discrepancy. That is to say, the designers and critics may be perfectly right in their estimate of the public demand. Paradoxically, they may be right even if people do *not* want distant reception. For at least one "man-in-the-street" has told me candidly that he invariably listens to the locals, but must have a set capable of reaching out, just for the psychological effect of possession. In that case, all the vast amount of thought and expense which are devoted to the production of long-range super-selective receivers is required merely to sell them.

Turning to the point of view of those who provide the sets, their estimate is based on two assumptions:—

(1) that the B.B.C. programmes are inferior to foreign ones, and

(2) that foreign programmes can be heard satisfactorily.

Dealing with the second point first, we all know that for every receiver it is claimed that stations from abroad can be heard "with quality indistinguishable from that of the local station," or, more modestly, "with good programme value." The motive for these claims is, of course, not always disinterested, but allowing for that there are some who would not regard them as far-fetched. The only thing I can say about this is that their conception of "local" quality must be considerably lower than mine. It is easy to make oneself believe quite sincerely, on tuning in to a far-off station, that reception is every bit as good as the best that can be obtained from a local. But this illusion is more difficult to sustain. The shop demonstration is no test, for the demonstrator takes good care to pass on to the next station in a few seconds.

There are perhaps a few exceptional stations and times, but it is not very wide of the mark to declare that no listener who insists on the highest obtainable quality of reproduction can be satisfied for long with reception from any station at a distance greater than about 300 times its wavelength. Fading, heterodynes, atmospherics, machine noises, all combine to mar the result. To mention only one objection: audio frequencies over 4,000 or 5,000 cycles cannot be received entirely free from interference unless the field strength of the wanted station is very much greater than that of adjoining wavelength channels.

Granting the truth of this, there are those who fall back on point (1): that the somewhat lower standard of reliability and quality of reproduction is far outweighed by the brilliance of the foreign programmes. One of the arguments in favour of sponsored programmes is that the greater revenue would permit of really first-class artists being engaged.

It is easy to accuse the B.B.C. of failing to make use of the best entertainment available, but it is very much harder to prove it by naming any person or item of appreciable value (other than those debarred by impediments such as copyright or contracts) excluded from British programmes. It must be remembered, too, that top-line celebrities of stage, platform, or elsewhere, are not necessarily good broadcasting personalities, and if they were, one can easily have too much of them.

My personal opinion, shared largely by the foreign listeners themselves, is that except for isolated items their programmes compare unfavourably with those issuing from these islands, and sets sold abroad must be guaranteed to receive Daventry clear of all others.

Are manufacturers of long-range receivers (i.e., substantially all receivers) catering for an imaginary demand, a merely psychological demand, or a real demand? They would be very pleased to know, for the perplexities of technical design are as nothing compared with the perplexities of estimating what the public wants.

"DIAGNOSTIC."

Are There Too Many Operators?

MY attention has been drawn to the correspondence appearing under the above heading in a recent issue of *The Wireless World*, and which subject, I think, is not completely treated.

Wireless operators do not, nowadays, secure appointments so readily as they did a year or so ago. Neither, for that matter, does anyone else. It is agreed that the guaranteeing of appointments is ambiguous, for if the Government Ministers and others in authority who have every facility at their disposal are unable to foretell the trend of events, how can any ordinary individual be expected to do so?

Even with shipping at its present very low state seagoing appointments are still obtainable by men who will seek them, but the day has passed when one can sit at home in "Slocum-in-the-Mush" and expect the employer to seek the operator.

A successful man will look around for a suitable outlet for his abilities when the one in which he is interested is passing through a bad time, and in this respect the man with a P.M.G. Certificate is most fortunately placed, for, with a suitable adaptation of his training, the whole field of broadcasting is open to him.

In conclusion, I might add that some of the men who have secured P.M.G. Certificates at this college recently have obtained seagoing appointments, one of these only having a second-class certificate. On the broadcasting side, those trained here for that work have secured appointments in all branches, but obviously a man who is only trained as a seagoing operator cannot expect to be engaged as a service engineer without additional training. Your correspondents should endeavour to realise that the fact of

a man having secured a P.M.G. Certificate does not signify that the holder knows all that there is to be known about wireless.

GORDON S. WHALE,
Colwyn Bay. The Wireless College.

Electrolytic Condensers

WE have read with interest Mr. P. R. Coursey's article on high-voltage electrolytic condensers, which appeared in *The Wireless World* on January 13th, 1933.

The publication of information about these condensers is a very good thing, but so far we have restricted our remarks to our own publications, particularly our booklet entitled, "The Design and Construction of Radio Power Units."

It is gratifying to note that in general Mr. Coursey agrees with us, but we feel compelled to comment upon his comparison of semi-dry with wet electrolytic condensers.

As manufacturers of both wet and semi-dry types, we are perhaps in a happier position to judge their relative merits, and it is our opinion that the wet type is more reliable. Our view is based on practical experience, as well as on the following grounds:—

(1) *Composition of Electrolyte.*—The wet type electrolyte contains 92 per cent. of water, while the dry type contains about 1/10 of this amount. Thus the dry type is ten times as sensitive to removal of water which is going on slowly by the electrolytic action of the leakage current. The wet type will continue to work perfectly until at the end of about ten years the level of the electrolyte becomes reduced below the top of the positive electrode. After this the capacity will slowly decrease.

(2) *Protection against Overload.*—The wet electrolytic condenser cannot be damaged by voltage overload, assuming that the current is limited to reasonable values, for example, 100 mA., which covers the use in most radio apparatus. Local charring of the liquid electrolyte is, of course, absolutely impossible, nor does the passage of the overload current do any harm, provided that it does not continue long enough to make a condenser approach boiling point.

The amount of electrolysis that takes place is measured by the product of current and time. Let us suppose that during the switching on surge an overload current of 100 mA. passes for ¼ minute. This is only equivalent to leaving the set switched on for an extra 33 minutes under normal conditions, supposing a steady leakage current at the normal voltage to be ¾ mA. We have taken an extreme example rarely to be met in practice. Overload currents are more usually of the order of 20 mA.

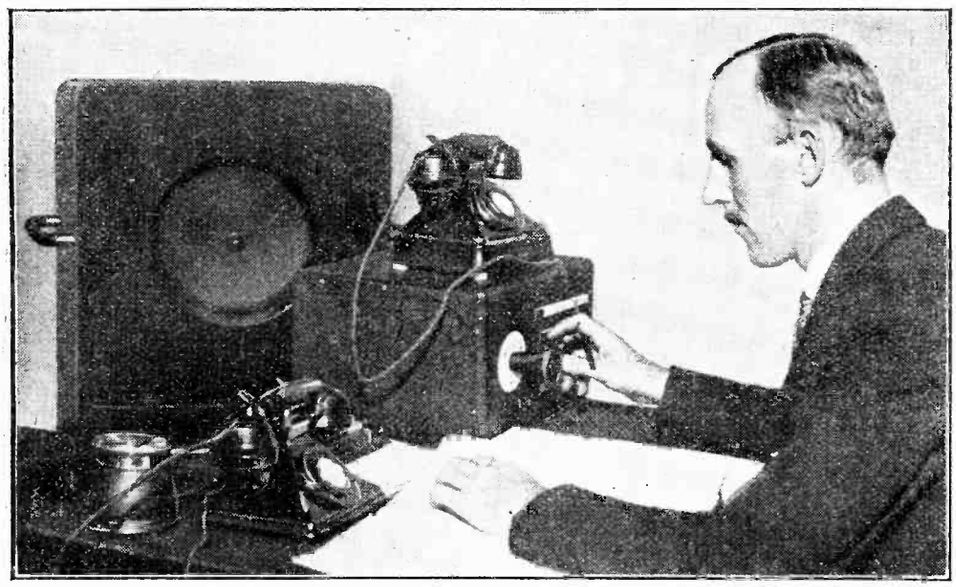
We should mention here that the voltage limiting action of the wet electrolytic condenser is a very useful property; for example, it is impossible to impress upon the 440 volt working wet electrolytic condenser a voltage much in excess of 460 volts, because the condenser acts as a temporary load until the ordinary anode current load rises to its full value. Thus the condenser, when used for smoothing, acts as a protection for subsequent apparatus.

(3) The liquid electrolyte is able to carry heat by convection to the surface of the container. There is absolutely no possibility of local high temperature. The statement that the power factor of the wet type may reach as high as 25 per cent. to 30 per cent. is liable to be misconstrued. Of course, if we desired to make a bad condenser this figure could be achieved, but, in fact, the power factor of our wet-type condensers, in consequence of improvements introduced last April, is 15 per cent. at 50 cycles, while the power factor of the high voltage dry type we agree may be from 5 per cent. to 10 per cent. according to type. The difference is not serious, however, in view of the easy dissipation of heat by the wet-type condenser and a 15 per cent. power factor has only a minute effect in reducing the effective capacity at 100 cycles.

To summarise, it appears that the dry type is useful when considerations of shape or position do not allow the use of the wet type with its far greater reliability.

As makers of both wet and semi-dry electrolytic condensers, we are able to make these comments without bias, as we are not influenced by considerations of which type becomes more popular.

THE TELEGRAPH CONDENSER CO., LTD.,
W. J. Cole, Managing Director.
London, W.3.



WATCHING POINTS. A supervising engineer at Broadcasting House checking the quality of transmission through a loud speaker fed from a check receiver. Quality is sometimes judged direct from the transmission lines between London and Brookmans Park.

CLUB NEWS

Demonstrating a Kit Set

THE Lissen "Skyscraper" Consolette was effectively demonstrated at a recent meeting of the City of London Phonograph and Radio Society. Mr. Clarke, the hon. secretary, admitting that the Kit was the first radio set he had constructed, stated that the assembly occupied him a few hours only. The results of the demonstration were impressive both as regards selectivity and sensitivity.

Hon. Secretary: Mr. R. H. Clarke, 5a, Tynemouth Terrace, Tottenham, London, N.15.

Ultra-Short Wave Work in Liverpool

A SUBJECT of great topical importance was dealt with under the title "Practical Ultra-Short Wave Work," by Mr. Eric C. Wilson (2AAZ), in a recent lecture before the Southport Society of Natural Science. After a comprehensive summary of the work already performed on the very high frequencies, Mr. Wilson mentioned that several Liverpool experimenters were now transmitting on 5 to 10 metres.

Hon. Secretary: Mr. John Clegg, 34, Scarisbrick New Road, Southport.

Rectification Explained

RECTIFICATION was the subject dealt with at a recent meeting of the Croydon Radio Society, when the lecturer, Mr. D. Ashby, of the Westinghouse Brake and Saxby Signal Company, explained the assembly of a metal rectifier and discussed the various ways of using it on A.C. mains. A film was shown illustrating generating stations of alternating current.

Hon. Secretary: Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

Radio Acoustics

ENTIRELY new ground was covered by Mr. A. S. Radford, B.Sc., A.R.C.S., at the last meeting of the Bristol and District Radio and Television Society at Bristol University, when he gave a lantern lecture and demonstration on "The Acoustic Side of Radio." He outlined the more recent developments of a new science which has grown up around the new industries of the gramophone, radio, and the sound film.

Hon. Secretary: Mr. G. E. Benskin, 12, Maurice Road, St. Andrew's Park, Bristol 6.

Power from the Mains

MEMBERS of the Burton Amateur Radio Society benefited by a very lucid explanation of Mains Transformers and Power Smoothing Chokes given by Mr. F. G. Sawyer, of Partridge Wilson and Company, at a recent meeting.

Full particulars of the Society can be obtained from the Hon. Secretary, Mr. W. A. Mead (G5YY), Addiscombe, Branstone Road, Burton-on-Trent.

Rotary Converters in Use

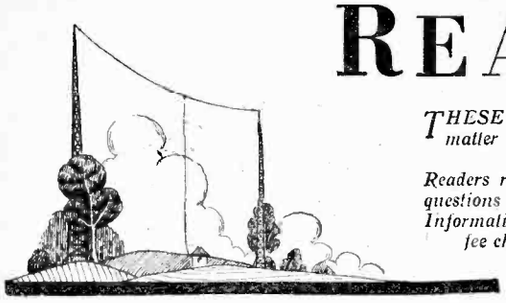
"ROTARY Converters" formed the theme of a lantern lecture given by Mr. R. H. Woodall, of Messrs. Rotax, Ltd., at a recent meeting of Slade Radio, Birmingham. Particular interest was shown in the hand type of rotary converter for use in emergencies and for generating sufficient current to summon help in remote parts of the world. A demonstration was given using an Eddystone All-Wave Four, H.T. and L.T. being supplied by a 6-150v. converter. The machine was entirely silent in operation, and it was stated that, using the converter, it was possible to get down to 8-10 metres in wavelength without interference.

Hon. Secretary: 110, Hillaries Road, Gravelly Hill, Birmingham.

In Kentish Town

THE Kentish Town and District Radio Society has resumed meetings after the Christmas recess with a very attractive programme. Meetings are held on Tuesdays at 8 p.m. at the Holmes Road School, London, N.W.5.

Hon. Secretary: Mr. Eric A. C. Jones (2BOC), 46, Lady Margaret Road, Kentish Town, London, N.W.5.



READERS' PROBLEMS

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Extra Smoothing

AS a rule, a loud speaker field winding when employed as a smoothing choke gives a sufficiently silent background for most purposes. In special cases, and particularly when the user of the set is intolerant of all extraneous noises, an additional smoothing choke is usually recommended.

A querist, who has decided that the hum level of his set might be reduced, asks us to suggest a value for the extra choke, and also to say where it should be inserted.

A choke with an inductance of about 10 henrys under working conditions should be adequate in such cases, and is obtainable with such low D.C. resistance that the loss in H.T. voltage should be practically negligible in the ordinary receiver. It should be inserted between the rectifier and the field winding, a large condenser being connected between the junction point and the negative H.T. line.

Always in Alignment

WHEN special care has been taken in the adjustments of a ganged tuning system it is, to say the least, disquieting to find that circuit alignment is no longer accurate when sensitivity is reduced for local-station reception. It is, of course, for short-distance work that one is naturally most eager to avoid any loss of quality due to imperfections in the tuning system.

The introduction of variable-mu valves has largely solved this problem, but those who are using other types of valves which do not permit of such perfect control of volume often encounter difficulties of this nature.

A reader who has fitted a "local-distance switch" in order to desensitise his set for reception of his local twin stations is disturbed to find that the input circuit of the set is detuned in relation to the others when the switch is put into use. Desensitising is actually effected by including a condenser of extremely low capacity in the aerial circuit. We are asked to suggest a method of compensating for the reduction in transferred aerial capacity that is brought about by this addition.

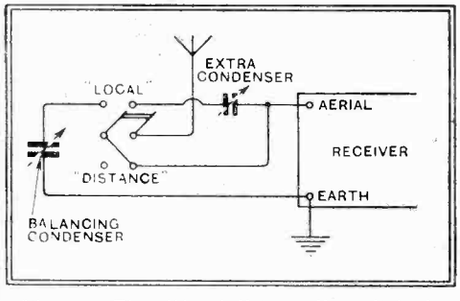


Fig. 1.—The "local-distance" switch is arranged to insert a small condenser in series with the aerial, and simultaneously to throw into circuit a balancing condenser which prevents alteration of tuning.

In this case we recommend the fitting of a semi-variable balancing condenser (of about 0.0003 maximum capacity) which may be connected to a double-pole double-throw switch in such a way that it becomes effective only when the switch is in the "local" position. The capacity of this condenser is set initially to the value which gives loudest signals with the switch in that position, and it will not need subsequent adjustment. Connections are shown in Fig. 1.

In order that sufficient reduction in aerial input may be made, it is worth while to point out that the extra aerial series condenser must often have a very low minimum capacity; a maximum of 0.0001 mfd. should be ample, and in many cases an even smaller condenser might be better.

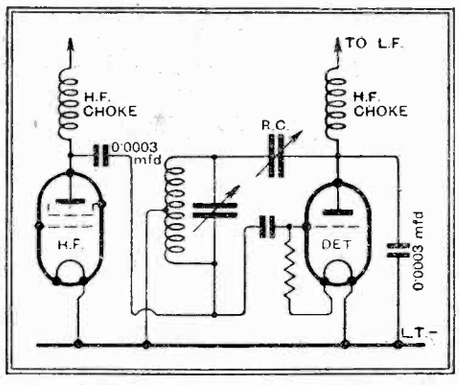


Fig. 2.—One of the simplest forms of tuned H.F. couplings; a separate reaction coil is not required.

Reaction Without a Reaction Coil

A READER who proposes to add a temporary H.F. stage to his receiver asks us to publish a circuit diagram showing how the functions of tuning inductance and reaction winding may be combined in a single centre-tapped coil which he wishes to use as a tuned intervalve coupling. He remembers having seen this arrangement described, but has forgotten the details.

The method that our correspondent has in mind employs the well-known "Hartley" circuit, and is shown diagrammatically in Fig. 2. This arrangement, although extremely effective from many points of view, has the disadvantage that it is not readily applicable to "ganged" receivers, but we assume this will not be a disadvantage in the present case.

The reaction condenser R.C. should have an extremely low value (say, 0.0001 mfd. maximum), and it is always worth while to experiment with the capacity of the detector anode by-pass condenser, for which a value of 0.0003 mfd. has been tentatively assigned in our diagram.

Connecting the Whistle Suppressor.

THERE seems to be some uncertainty as to how the Whistle Suppressor (*Wireless World*, Oct. 28th) should be connected to a loud speaker when a choke output system is employed as a link with the last valve.

With the simplest possible arrangement, where the loud speaker is fed directly from an untapped choke, giving in effect a 1:1 ratio, it is a matter of complete indifference whether the anti-interference device in question be joined across the loud speaker windings or the choke. Readers can suit their own convenience in this matter, but will usually choose the loud speaker, as its terminals are likely to be rather more accessible. The same remarks apply when a low-resistance loud speaker is coupled by means of a step-down transformer, which in turn is fed from an untapped choke; in this case the suppressor may be joined across either the choke or the transformer primary —never across the secondary.

But where a tapped output choke, acting as a step-down auto-transformer, is employed with a pentode valve, the best place for the suppressor is across the choke—not the loud speaker or the primary of its transformer, if one be fitted. It should be remembered that the device works best in conjunction with a circuit of high impedance, and in the present case it is obviously best that it should work in parallel with the whole of the choke, and not merely with a section of it.

Not Worth While

THOSE who use an output valve capable of delivering but a few hundred milliwatts may question the desirability of outputs in the order of 2 or 3 watts. But even if one does not wish for reproduction of great volume, it is an undoubted advantage to have a big margin of safety, and few who have become accustomed to a modern high-power set would willingly go back to anything less ambitious.

Attempts to increase the undistorted output from an existing receiver are entirely laudable, but it should perhaps be pointed out that it is hardly worth while to go to great expense to increase output unless, say, power is to be at least doubled. For instance, a correspondent writing to us on the subject of improving his receiver proposes to take a great deal of trouble in order to make it possible to employ an output valve which is rated to give about 40 per cent. more power than that which it is to replace. An increase of 40 per cent. corresponds only to about 1½ decibels, which represents a barely audible increase in volume.

The Wireless World

INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.