NEW SCIENCE MUSEUM RECEIVER

4D

The Wireless World AND RADIO REVIEW

The Paper for Every Wireless Amateur

Wednesday, July 30th, 1930.

No. 570. Vol. XXVII. No. 5.

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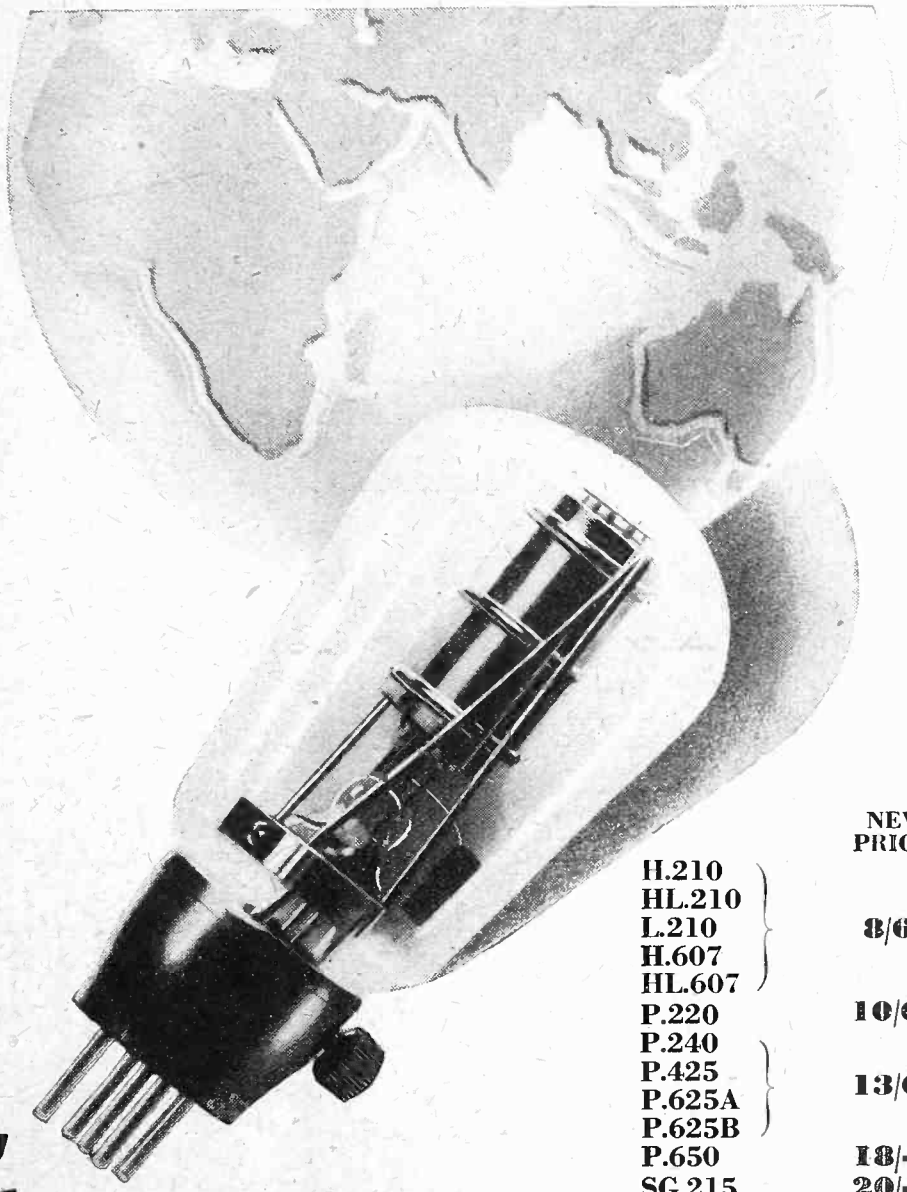

	NEW PRICE	OLD PRICE
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The Wireless World AND RADIO REVIEW

(18th Year of Publication)

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

CONTENTS OF THIS ISSUE.

BROADCAST PROPAGANDA.

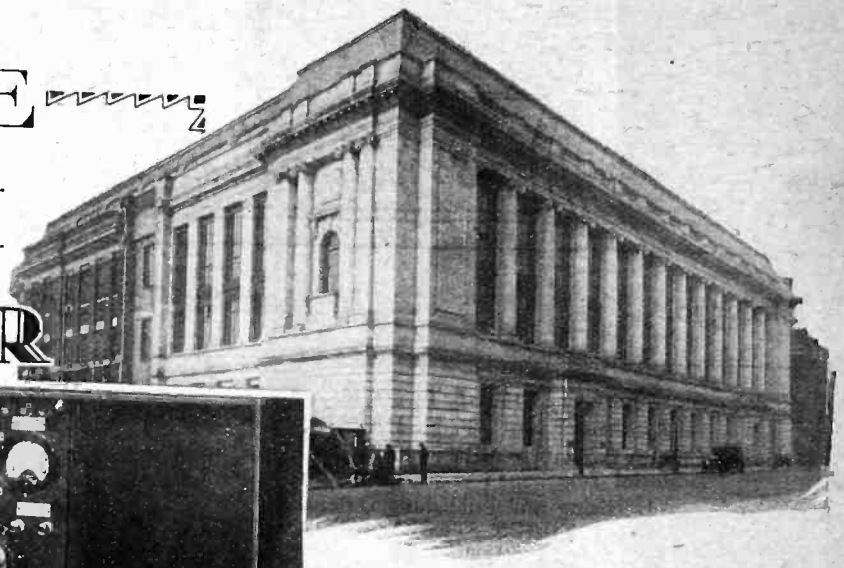
A READER, Mr. Bertram Munn, who contributes to our Correspondence columns in this issue, has a good deal to say on the subject of advertising through the microphone, and he makes it quite clear that he is a strong supporter of the sponsored programme, not presumably because he likes advertising thrust upon him, but because he wants better programmes. His view is briefly summed up in the final sentence of his letter: "What is an occasional jar from an advertisement compared with the present chronic irritation caused by mediocre programmes?"

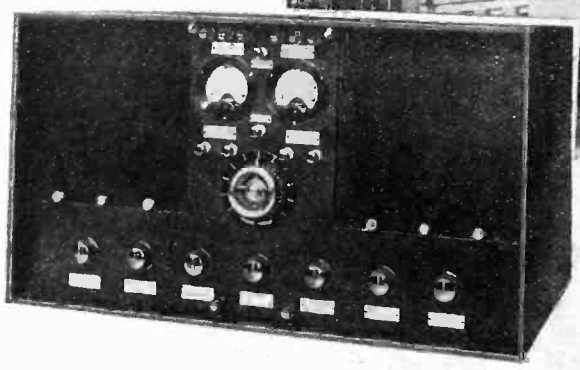
If one could see that by permitting advertising in broadcasting we should at once effect a cure for all the shortcomings for which our present programmes are blamed, then we think that the idea of advertising by the microphone and sponsored programmes would deserve closer investigation. But what guarantee have we that, even if we were to hand over broadcasting so that every programme became a sponsored programme, the satisfaction of the public would be any the greater? The B.B.C. has ample funds available for the compilation of the programme matter, and we doubt very much whether what various sections of the public choose to describe as the "poor quality of the programmes" is in any measure due to lack of funds. The B.B.C. is in a position to gather around it better talent, and more of it, than the organisers of any independent sponsored programme could hope to find, and the absence of outstanding artistes from microphone programmes is far more often due to contracts which prevent them from broadcasting than to lack of sufficient funds with which to remunerate them for their services.

Where Advertising may be Justified.

If we make any exception in the matter of advertising by the microphone, then let us see to it that it is put to a useful purpose. The B.B.C.'s service does not require to be subsidised by revenue from advertising. Those who very wisely established the constitution and organisation of our broadcasting service in the first place made provision for meeting the cost of broadcasting out of licences, and their intention at the time was to preclude the necessity for the service to have to look elsewhere for funds. But if we review the position with regard to a short-wave Empire Broadcasting Service we may then find that the situation is different: for funds are not yet available for the service, nor is there any simple machinery possible which would ensure collection of the necessary revenue from those who will make use of the service. We are therefore prompted to think that advertising in some suitable form may not only solve the problem of meeting the cost of an Empire Broadcasting Service, but may, at the same time, serve a very useful purpose in stimulating Empire trade. We have previously put forward this suggestion when discussing the question of funds for 5SW in our issue of November 6th, 1929. On that occasion we made the proposal that the Empire Marketing Board might be considered as an authority on whom the task of financing the short-wave service might be imposed. This authority, we explained, has as its object the development of trade within the Empire, and we contended that there could be no objection to the Empire Broadcasting Service being utilised to help in such an object as the stimulation of inter-Empire commerce. We expressed the view then, which we still maintain to-day, that no one would quibble at the Empire Broadcasting Service being put to such a use as this, particularly when by this means the problem of funds for programmes and stations might be solved.

SCIENCE MUSEUM RECEIVER





By
R. P. G. DENMAN, A.M.I.E.E.,
and
A. S. BRERETON, M.A.

Details of an Equipment Designed for Purposes of General Reference.

IT is now five years since one of the authors first proposed the erection at the Science Museum, South Kensington, of a broadcast receiver which by reason of careful design and strict maintenance might come to be regarded as a standard of reference from the point of view of fidelity in reproduction. The power and size chosen for this purely local-station receiver contrasted rather strikingly with the battery-driven sets then in common use, but the fact that, thanks to the development of mains equipment, there are now quite a number of commercially manufactured sets having a distortionless output of like magnitude should dispose of any suggestion that the power was excessive. It was, indeed, entirely insufficient to secure that ideal condition which the authors have kept before them in designing the receiver which is presently to be described. This is that no link in the chain between aerial and loud speaker shall be allowed to become overloaded until the intensity of the sound reaching the listener is greater than it would be if he were hearing the original performance.

WITH the praiseworthy object of demonstrating the possibilities of high-quality broadcast reproduction, the National Science Museum authorities installed, in the autumn of 1925, a receiver representing the most advanced design of its time. This is about to be replaced by a more up-to-date set, in which push-pull power grid detection replaces a diode rectifier. To preserve the side-bands of the modulated transmission the single H.F. stage contains filter circuits giving a flat-topped resonance curve, whilst fidelity of reproduction in the L.F. amplifier is maintained by the use of a paraphase amplifier.

Usually in receivers it is necessary to restrict the volume to some lower level at which the last stage (or perhaps the penultimate stage) is just not overloaded, but by assigning conservative engineering values throughout the set it is possible (though with some difficulty) to shift the onus of responsibility for overloading on to even the largest loud speaker that may be connected to it. This, in the present case, is a moving-coil unit with a 27ft. logarithmic horn having a lower cut-off frequency of 32 cycles per second,[1] designed for use with a 555W unit and a special equaliser arrangement.

The first step in the design of the new receiver was to settle the output power, and this was ultimately fixed at 40 watts. Since the safe power-handling capacity of the 555W unit is about 13 watts this might be thought excessive, but efficiency is a secondary consideration in the design of a large output transformer which is to have a good frequency characteristic, and subsequent tests have shown that only about 10 watts are actually transferred to the horn unit. Assuming that the efficiency of this unit is 25 per cent., the maximum acoustic output is about 2.5 watts, equivalent (since an average singer develops a peak power of 15 milliwatts) to a mixed choir of 150 voices.

Some difficulty was experienced in obtaining output valves and suitable rectifiers for 40 watts. The valves chosen for the output stage are at present only manufactured in the United States, but it is understood that they will soon be made in this country by the B.T.H. Company. They call for an anode potential of 1,000 volts and a grid swing of ± 150 volts, under which conditions they are capable of giving an output of 20 watts with 5 per cent. harmonic distortion.

The design of a penultimate stage which will deliver the required grid swing to these valves is evidently a matter requiring some care, and as no indirectly heated cathode valves now made will accomplish this without

[1] See *The Wireless World*, July 31st, 1929, p. 97.

Science Museum Receiver.—

themselves becoming overloaded it has been necessary to employ filament-heated valves (L.S.5) at a high anode voltage.

After some further consideration of the low-frequency amplification stages the authors decided to adopt the valuable "Paraphase" scheme of connection patented by Mr. R. E. H. Carpenter.[2]

The Paraphase Amplifier.

In this two separate amplifying chains are used, the input to the second chain being derived from the first anode circuit of the main chain. This virtually produces a 180-deg. phase difference between opposite anodes and grids throughout the amplifier, so that if the valves are well matched and the proper adjustments made, certain unwanted additions to the original signal, e.g., hum components and second harmonics originating within the amplifier, give rise to opposing E.M.F.s in the two chains and are automatically cancelled in the output transformer; while the signal voltage proper, which is applied in opposite phase to each chain, produces an additive effect.

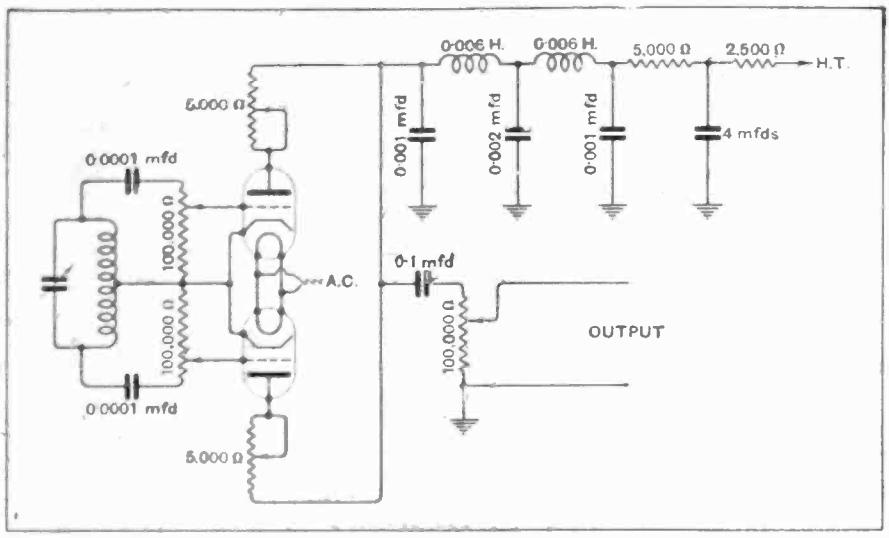


Fig. 2.—Push-pull detection with Campbell low-pass filter.

A receiver so connected combines the advantages of phase-opposition working (push-pull) with those of resistance-coupling. As regards the former, a pair of output valves connected in push-pull will deliver about twice as much power to a loud speaker (for the same amount of harmonic distortion) as will the same two valves connected in parallel, provided that they are well matched. As regards the latter, comparative tests carried out by the British Broadcasting Corporation with resistance-capacity and transformer-coupled amplifiers having identical frequency-response characteristics leave no doubt whatever that audible distortion can be produced by one or more transformers,[3] and there is definite evidence that a marked improvement in quality will be observed when means have been found to preserve, throughout the broadcast system, a constant value for the expression

$$\frac{d\alpha}{d\omega}$$

where α is the phase angle of any modulation component of frequency $\frac{\omega}{2\pi}$

Push-pull Power Grid Detection.

Before the design of the low-frequency amplifier could be proceeded with it was necessary to settle the problems of the detector stage. The advanaages of anode-bend "Power" detection had been pointed out by several writers, but in the course of their experiments the authors failed to discover any *indirectly heated* valve which was satisfactory for anode-bend detection, and it seemed clear to them that such detectors could

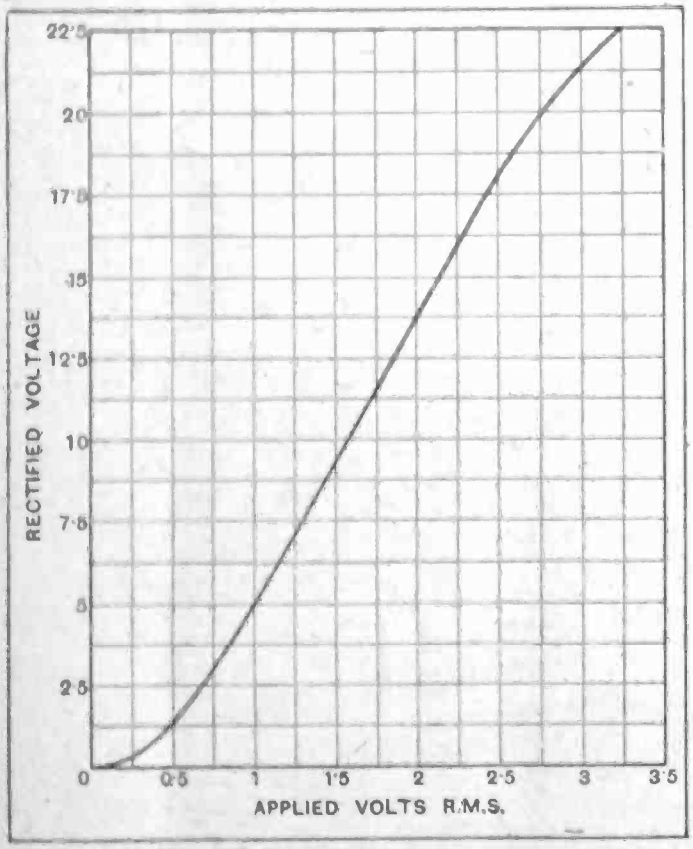


Fig. 1.—DETECTOR CHARACTERISTIC. Mullard 164 V. External anode resistance 6,000 ohms; Anode voltage 278; Steady anode current 16 mA.

[2] British Patent Specification No. 325833. See also F. Aughtie, "Push-pull Amplification," *Experimental Wireless and Wireless Engineer*, June, 1929, p. 307.

[3] In the B.B.C. tests various amplifiers having identical steady-state characteristics were included between a microphone and a loud speaker, and the quality compared on noise, speech, piano and xylophone. The paraphase amplifier was unquestionably the best. A straightforward resistance-capacity amplifier without iron, except in the output components, came second. The least satisfactory arrangement was a resistance-capacity push-pull amplifier with input and output transformers, these latter being choke-capacity coupled. It is to be noted that this last arrangement is (at present) standard in the B.B.C. control rooms.

Science Museum Receiver.—

not be regarded as distortionless for heavily modulated signals. They accordingly began to investigate the possibilities of the indirectly heated valve as a grid detector, and were immediately rewarded with such curves as that shown in Fig. 1.[4]

Next, two grid detectors with push-pull input and parallel output connections were tried, the method of connection being that shown in Fig. 2. This arrangement removed the greater part of the high-frequency signal component from the anode circuit, and freed the high-frequency stage from the load which would otherwise be thrown back to it by virtue of the detector inter-electrode capacity. As an additional precaution a Campbell low-pass filter was included in the detector anode circuit to take care of any residual high-frequency component caused by an imperfect balance between the detector valves.

At this stage the authors encountered the work of Mr. W. Greenwood, of the B.B.C., who had noted another very interesting point, viz., that with this method of connection the grid condensers are not necessary. Their removal makes it possible to increase the resistance of the grid leaks, and therefore the efficiency, without detriment to the frequency-characteristic.[5]

Mr. Greenwood has published a full description of the push-pull method of grid detection,[6] and it is therefore unnecessary to say more of it here, except that it merits wide adoption.

The simplified diagram of connections is given in Fig. 3. Two separate pre-set H.F. stages are used, so that either the National or the London Regional Programme may be readily chosen. In each case the aerial tuning circuit is intentionally damped, and advantage is taken of the properties of tuned circuits to secure a flat-topped response curve.

Separate (de-coupled) grid-bias arrangements are provided for each valve by means of a variable resistance inserted between each cathode and the negative H.T. lead.

An Interesting Clock Switch.

The figures given in the diagram of Fig. 3 illustrate the method adopted in designing the intermediate stages. The external anode resistances are between three and four times the internal valve resistances, and the volume control, valves, anode voltages and bias values are so chosen that a modulation of 100 per cent. cannot overload the last stage. Previous stages are worked at a maximum input 50 per cent. less than their voltage handling capacity.

No batteries are used. Alternating current at 230 volts, 50 cycles, is taken in and supplied to transformers through a specially designed clock-switch which

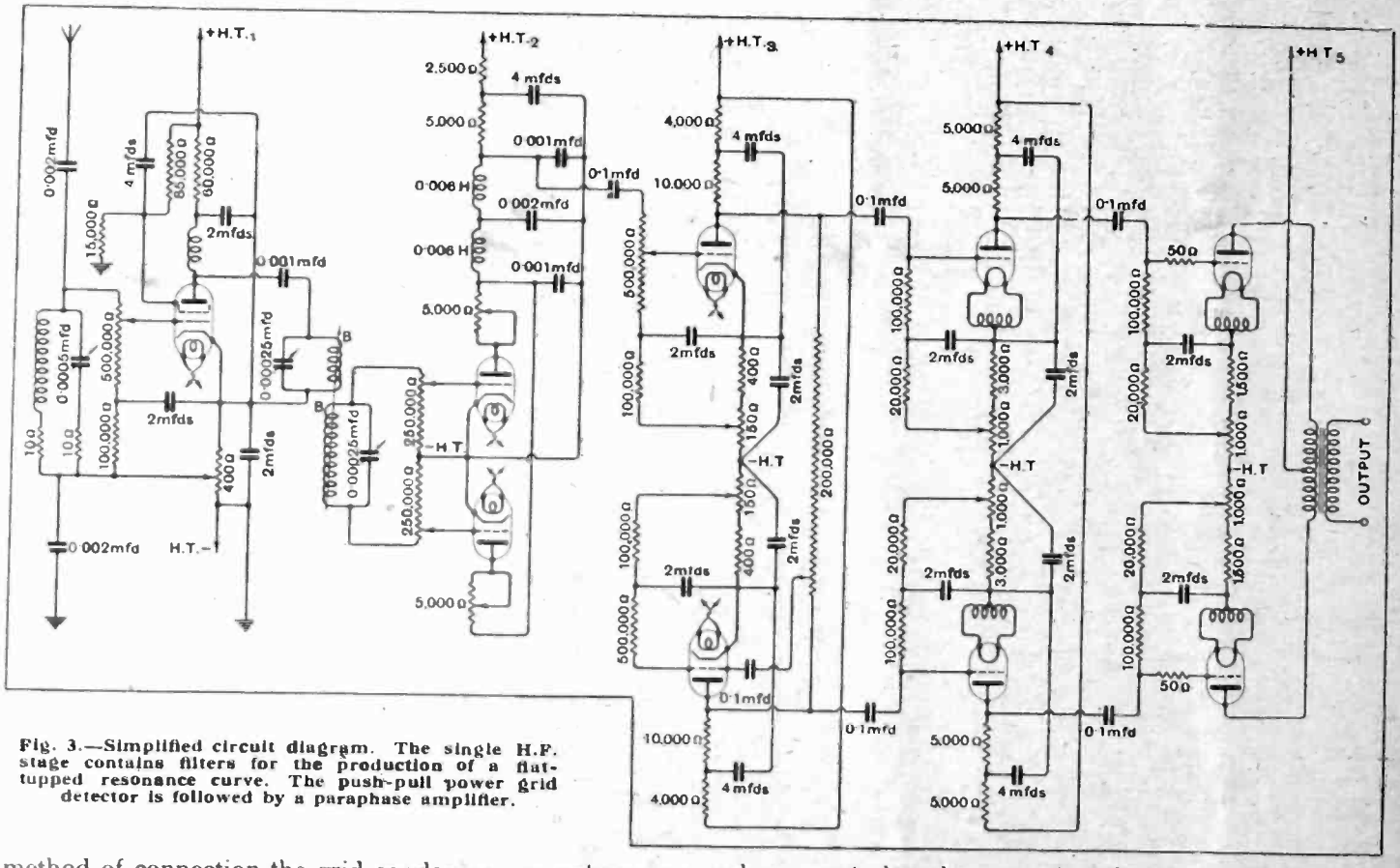


Fig. 3.—Simplified circuit diagram. The single H.F. stage contains filters for the production of a flat-topped resonance curve. The push-pull power grid detector is followed by a paraphase amplifier.

[4] These curves, which were obtained with Mullard 164V valves, were shown to Mr. A. L. M. Sowerby, who subsequently obtained similar results with Marconi valves. See also W. T. Cocking, "Power Grid Detection," *The Wireless World*, May 7th, 1930, in which this method of detection is described.

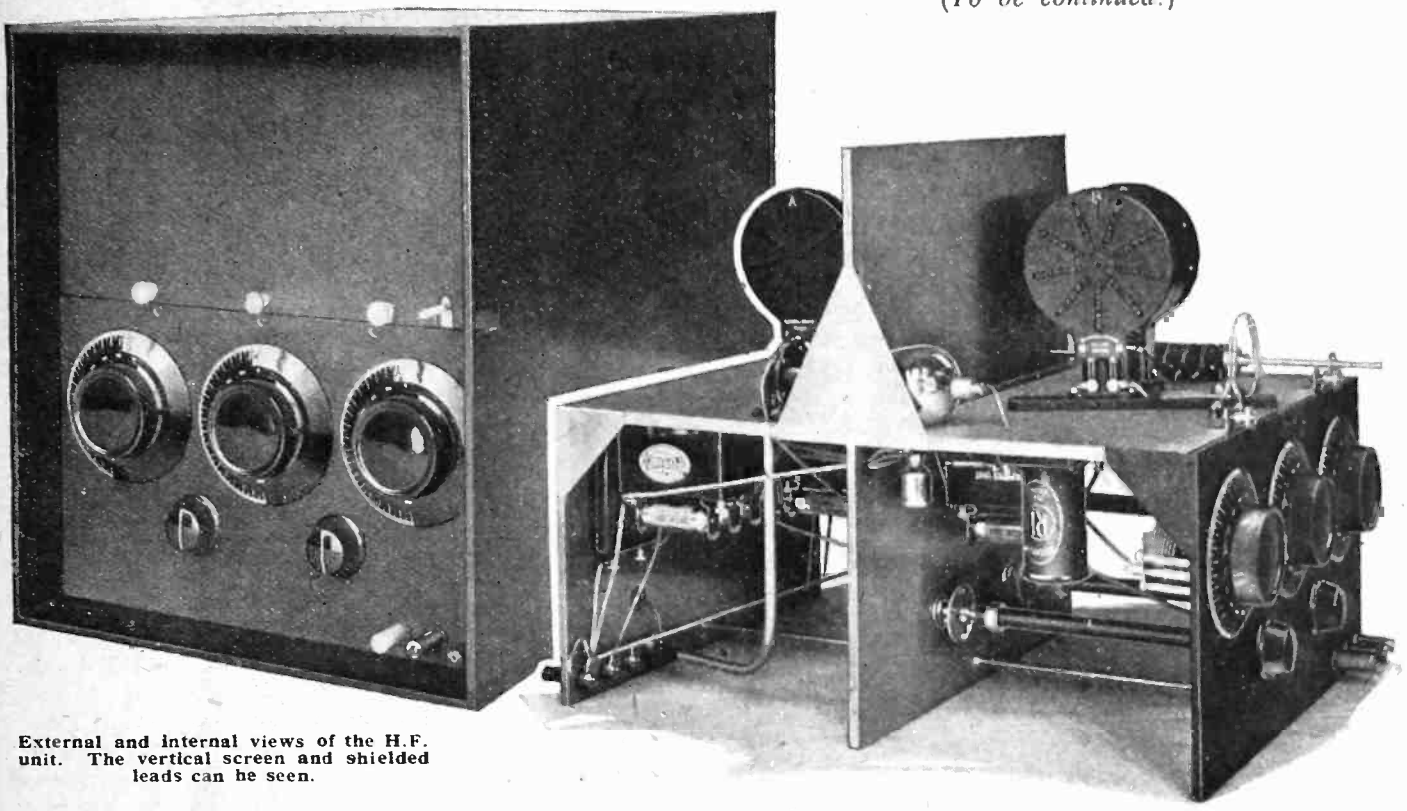
[5] The circuit shown in Fig. 2 will only work without the two grid condensers if the coil centre tappings are removed.

[6] See *World Radio*, April 4th, 1930, p. 535, and subsequent issues.

Science Museum Receiver.—

gives time for the filaments to heat up before the high-tension voltages are applied. The early stages of the set are supplied with current at 480 volts through an ordinary two-wave rectifier and smoothing circuits. For the final stages a pair of hot-cathode mercury rectifiers are used, the transformer being wound to give 1,200 R.M.S. volts. Metal rectifiers are used for the detector heaters and for the low-voltage winding of the large horn loud speaker, a special equaliser for which was worked out and presented to the Museum by Standard Telephones and Cables, Ltd.

(To be continued.)



External and internal views of the H.F. unit. The vertical screen and shielded leads can be seen.

14-megacycle Waveband.

News from Ceylon states that reception conditions on 21 metres were very patchy during the week ending June 28th. Great Britain came through only at intervals and fading was much in evidence. Among the stations heard were G5WT, G6VP, G2OL, and G2NM.

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British Arctic Air Route Expedition.

The Expedition bound for Greenland in Shackleton's historic ship "Quest," which sailed from London on July 6th, expects to set up base camps about the middle of August, one on the south-eastern coast of Greenland and the other 150 miles inland. The call-sign of the Expedition is GKN, and the wireless operator has arranged a regular schedule with G2CW, of Bath, nightly at 22.00 B.S.T.

The object in view is to establish an all-British air route across the Arctic regions to Canada, and the equipment includes aeroplanes, fast motor boats and sledges. From the central base exploring parties in dog sledges will journey northward, southward, and to the coast.

The meteorological section of the Expedition intends to remain at the main base for a whole year, this being the first time that an Expedition has spent a winter at such a high altitude in the Arctic. According to news lately received the party has reached the Faroe Islands, where dog teams are being embarked.

TRANSMITTERS' NOTES.

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Transmissions from Bangalore.

Dr. H. E. Watson (VU2BF), of the Indian Institute of Science, Bangalore, transmits on Sundays at 12.30 and 9.30 p.m. Indian Time (05.30 and 14.30 B.S.T.) on 75 metres. Before starting his telephony he sends I.C.W. for five minutes to enable listeners to tune in. He will welcome reports.

oooo

Picking up the "Southern Cross."

Mr. H. B. Old was indefatigable in picking up messages from the "Southern Cross" during the monoplane's recent flight across the Atlantic. For over 30 hours he remained at the short-wave receiver in his station G2VQ, at Mapperley, Nottingham, taking down messages transmitted by Mr. Stannage, the wireless operator, some of which were communications to his parents living near Melton Mowbray, who, on the arrival of the "Southern Cross" in New York, were able to listen, at G2VQ, to their son speaking over the microphone after landing.

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International Short-wave Radio League.

A society of short-wave listeners has recently been formed in U.S.A. "to create international friendship through the short-wave medium and to bring the short-wave listeners, clubs and experimenters, in all corners of the globe, into one big family."

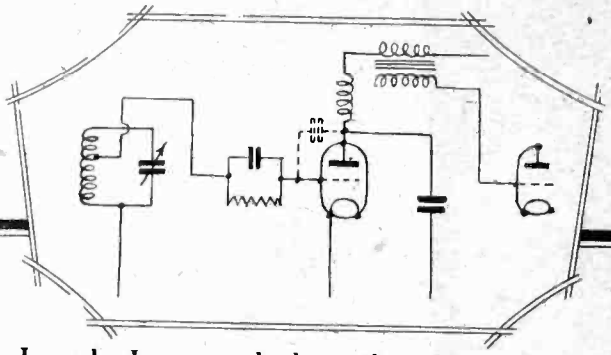
The official organ of the Society, "The Short-Wave Searcher's Guide," is to be issued quarterly, beginning next September, while supplements containing the latest changes of wavelengths, new calls, etc., will from time to time be issued to members. The annual subscription is $1.75, and full particulars may be obtained from the Hon. Secretary, Mr Clifford Daly, Jamaica Plain, Boston 30, Mass.

oooo

New Call-signs and Changes of Address.

G6NZ	L. E. Newnham, 18, Baffins Rd., Copnor, Portsmouth. (Change of address.
2AAL	F. L. Postlethwaite, 41, Klnfauns Rd., Goodmayes, Ilford, Essex.
2ACK	V. A. Sims, 29, Rochford Ave., Westcliff-on-Sea.

DETECTOR DAMPING



Measuring the Load Imposed by the Power Grid Detector.

By W. T. COCKING.

SINCE its first description a few weeks ago the Power Grid Detector has become very popular. The benefits of distortionless output and high sensitivity have been well appreciated, but the loading of the preceding tuned circuit is a disadvantage. In this article, as a result of actual measurement, the interesting conclusion is reached that the damping due to grid current is almost negligible, whereas that due to the reverse reaction brought about by the anode-grid capacity of the valve is of large magnitude. Various methods of combating the ill-effects of this form of loading are described.

It has recently been shown in these pages that the power grid detector[1] has characteristics more linear than those of any other rectifier, with the exception of the diode. As it is also the most sensitive method of detection, it is the most suitable for general use in high-quality receivers. In common with all grid detectors, however, it imposes a considerable damping upon its tuned input circuit, and it becomes of importance to determine the magnitude of this damping under ordinary conditions, and to find means for its reduction.

A tuned circuit is affected in two ways by the grid detector. In the first place, the internal grid A.C. resistance of the valve is in parallel with the circuit, thus increasing the effective H.F. resistance and reducing the efficiency. A more serious cause of damping, however, is the effect of the anode circuit of the valve upon the grid circuit. It is not always realised that the normal constants of the tuned grid circuit may be profoundly modified by the nature of the anode circuit load impedance. It has been shown by W. I. G. Page[2] and W. B. Medlam[3] that the anode bend detector damps its input circuit because of the grid-anode inter-electrode capacity of the valve, and this is also true of the grid detector.

High-frequency currents appear in the anode circuit of the detector, and flow through the anode circuit H.F. load impedance, which is usually the by-pass condenser. The reactance of this condenser is usually sufficiently high to allow an appreciable voltage to be developed across it. This voltage causes a current to flow through the grid-anode inter-electrode capacity of the valve, and a voltage to appear at the grid. Now the magnitude of this voltage depends upon the valve constants, including the grid-anode capacity, and upon the value of the anode circuit load impedance; but its effect depends upon the phase of the fed-back voltage, which is governed by the nature of the anode circuit load impedance.

With an inductive load impedance the feed-back is in phase with the applied H.F. voltages, and regeneration occurs; and, under suitable conditions, oscillation. The usual load impedance in the anode of a detector, however, is capacitative, and the feed-back is then out of phase with the applied voltages, and anti-regeneration occurs, with damping of the input circuit. The magnitude of the feed-back is governed by the high-frequency amplification of the valve, and by the capacity of the condenser formed by the valve electrodes. This accounts for the fact that, other things being equal, feed-back is smaller with an anode bend detector than with a grid detector; for in the former case the anode A.C. resistance is of necessity much higher, with a consequent lower H.F. amplification.

Now the effects of this feed-back are most easily expressed as an alteration in the effective H.F. resistance of the tuned circuit. Just as the effects of reaction are expressed as a reduction in the H.F. resistance, so may the effects of anti-phase feed-back be expressed as an increase in this resistance. It must not be forgotten, however, that a tuned circuit, the resistance of which is thus artificially altered, may not always behave in exactly the same manner as a circuit which has as a natural constant the same value of resistance.

In order to determine the magnitude of the losses likely to be experienced in practice with power grid detection, the writer carried out a series of measurements on the Mazda AC/HL valve. The circuit used is shown in Fig. 1; a valve voltmeter was connected across the tuned input circuit to measure the H.F. voltage applied to the detector, while a milliammeter in the detector anode circuit recorded the change of anode current due to rectification. A 0.0001 mfd. grid condenser with a 0.15 megohm leak were used, and the steady no-signal anode current through a 20,000 ohms anode resistance was kept constant at 8.5 mA. A low-frequency amplifier was added to give an audible check on results. In

[1] "Power Grid Detection." *The Wireless World*, May 7th, 1930.
[2] "The Valve as an Anode Detector." *The Wireless World*, March 13th and March 27th, 1929.
[3] "Improving Detector Efficiency." *The Wireless World*, May 22nd, 1929.

Detector Damping.—

taking the curves the coupling to the source of H.F. current was kept constant, and the H.F. grid voltage and anode current change were noted for different values of the by-pass capacity C. It was found that with a large H.F. input misleading results were obtained, owing to the detector becoming overloaded. An average value, therefore, was chosen for the input, as most nearly representing practical conditions.

The results are shown in the curves of Fig. 2, in which curve A shows the variation in H.F. input R.M.S. voltage, and curve B the variation in detector anode current change, for various values of by-pass capacity. It will be noted that the larger the capacity of the condenser the greater is the input voltage, indicating lower damping of the tuned circuit, due to smaller feed-back. The curve for anode current change is almost parallel

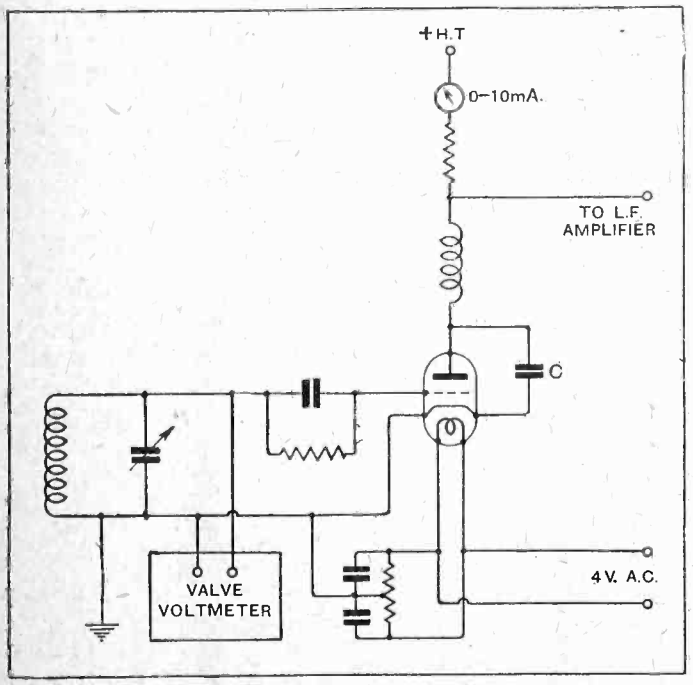


Fig. 1.—The circuit used for the experiments in connection with the calculation of the input load imposed by the power grid detector..

with that for input volts, which shows that the rectification efficiency is almost constant. With capacities higher than about 0.002 mfd., however, the change of anode current is not quite proportional to the input, as the detector is slightly overloaded with the larger input given by this value of capacity.

Although these curves show the reduction of input due to feed-back, they do not show the apparent increase of H.F. resistance of the tuned circuit. In order to obtain figures for this, the H.F. resistance of the coil, including the damping due to the valve voltmeter and the AC/HL valve base and holder, was measured and found to be about 25 ohms at 250 metres. The grid A.C. resistance of the valve was then determined by connecting a 1 mfd. condenser between the anode and cathode to reduce feed-back to a negligible amount, and re-measuring the tuned circuit resistance. The coil H.F. resistance was then found to be some 36 ohms, showing that the grid

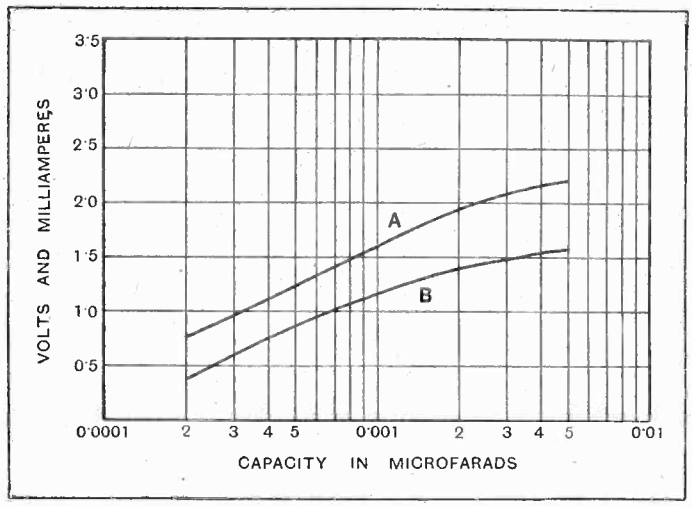


Fig. 2.—In curve A the variation in H.F. input voltage with change of by-pass capacity is shown. Curve B shows the variation in anode current change with change of by-pass capacity.

A.C. resistance was about 200,000 ohms; a much better figure than was anticipated from an inspection of the valve characteristics.

The Effect of a Larger By-pass Condenser.

The effective series resistance *added* to the tuned circuit by feed-back alone could then be calculated, and this is given in curve A, of Fig. 3, while curve B shows the total series resistance of the circuit. It will be seen that the resistance added by anti-phase feed-back is very serious when a small capacity by-pass condenser is used. With a 0.0002 mfd. condenser, the resistance added by feed-back alone is 127 ohms, while even a 0.001 mfd. condenser introduces some 40 ohms resistance into the circuit. If the anode resistance be 20,000 ohms or less, however, it is quite permissible to use a larger by-pass

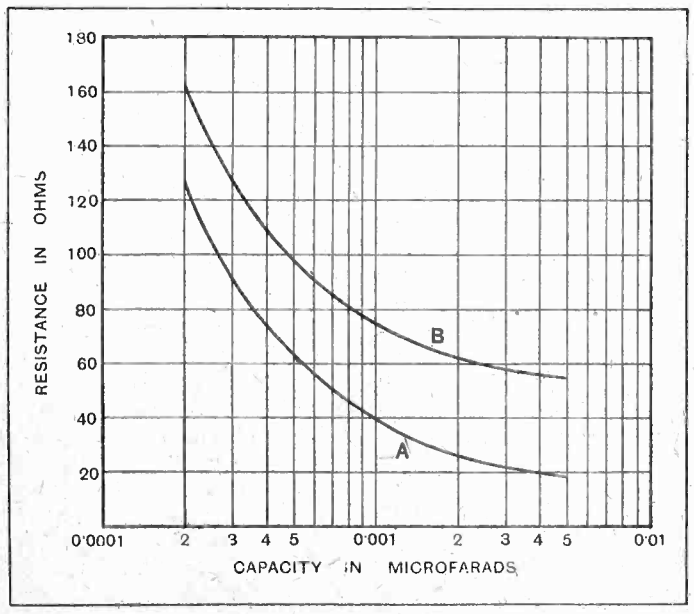


Fig. 3.—The increase of circuit resistance due to feed-back alone is given in curve A, while curve B shows the total series resistance of circuit including all valve damping.

Detector Damping.—

capacity than this; and a 0.002 mfd. condenser, which adds only 25 ohms resistance to the grid circuit, is quite satisfactory from the point of view of quality.

The same results are shown in Fig. 4, but they are expressed as an equivalent resistance connected in parallel with the tuned circuit, as this is more convenient when designing a high-frequency amplifier. Curve A shows the losses introduced by feed-back alone, while curve B indicates the total losses due to the detector.

It is obvious that the most effective method of eliminating this damping would be the elimination of the feed-back itself; and the best method of doing this would undoubtedly be the use of a screen-grid valve. Unfortunately, however, the ordinary screen-grid valves have unsuitable characteristics; and, pending the development of an entirely new type of valve, we must look for improvement in other directions. Two methods exist, and these were explained in some detail in the

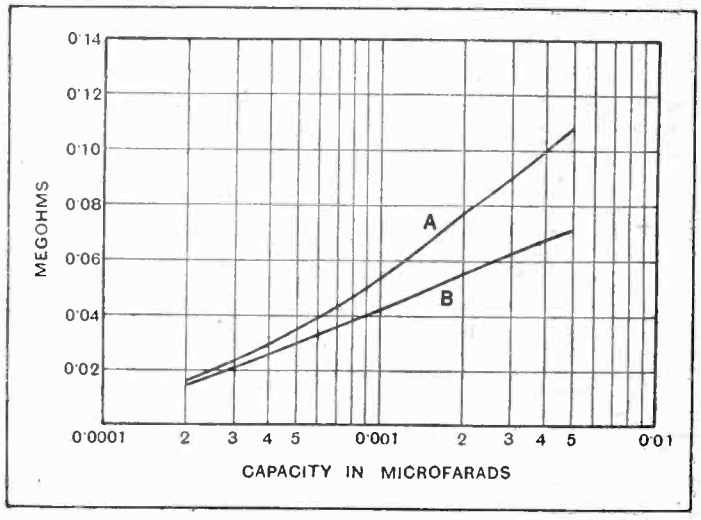


Fig. 4.—Equivalent shunt resistance due to feed-back alone (curve A) and equivalent shunt resistance due to all detector losses (curve B).

two articles on anode-bend detection already referred to—neutralising, and the use of a series resonant output circuit. The former has the disadvantage of a coil tapped at its centre—a point which may not coincide with the optimum tapping for reduction of loading. The alternative is to connect a series resonant circuit in place of the usual by-pass condenser; but this has the disadvantage of adding another tuning control to the set, and a control which adds to the selectivity only in so far as it reduces damping.

In practice, the most satisfactory method of reducing damping is to connect the grid lead of the detector, not to the top of the tuned circuit in the usual manner, but to a tapping on the coil. The exact position of the tapping can easily be found by experiment, but a position such that two-thirds of the coil is included in the grid circuit is usually satisfactory.

The damping, however, is not as serious in practice as would appear from an inspection of the curves illustrating this article. The numerous stray reactions always present in an H.F. amplifier reduce the damping to a considerable extent. In any case, the selectivity can be made considerably higher than that with an anode-bend detector by the simple process of adding an extra tuned circuit, preferably in the form of a band-pass filter. Where H.F. amplification is not used, the damping is of little importance, since its effects can be entirely removed by the application of reaction; and where this is considered undesirable, an extra tuned circuit is again indicated. It is thought that the better quality and the higher sensitivity of the power-grid detector are well worth a small sacrifice in selectivity, when this last can so easily be made up by the addition of one extra tuning coil and condenser.

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A FIRST ELECTRICAL THEORY FOR SCHOOLS.[1]

By H. W. HECKSTALL-SMITH.

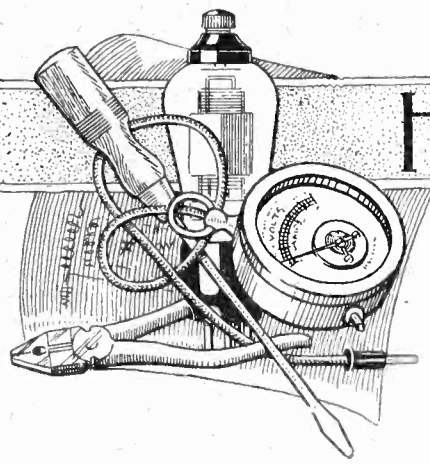
This is a school text-book which leaves with the reader two vivid and all too rare impressions. One is that the author is interested in teaching not only the elements of electricity and magnetism, but also the elements of the right way to think scientifically; the other is that he dares to think it no crime to learn and smile at the same time. This does not mean that he wastes time lecturing on "The Correct Attitude towards Science" or making jokes. The fact that in the compass of less than 290 pages he starts from scratch (or, rather, our old friend Gilbert rubbing his familiar piece of amber) and ends with the equation for calculating the frequency of an X-Ray, shows pretty clearly that no time or space is frittered away. And in those comparatively few pages he seems to neglect nothing that deserves attention; the merry but short life of the average H.T. accumulator when charged at three amperes at the local garage is dealt with; even the possibility of the earth's magnetism being due to electron-currents in the upper atmosphere is discussed, and the reflection of wireless waves from the Heaviside layer—but is not 20 miles rather low, even for the lowest layer?

Indeed, the reviewer was left with the uncomfortable feeling that he himself must have wasted time at school to an appalling extent when he realised that in the 334 pages which comprise the book, with its introduction, appendices and sets of questions, and which give the impression (no doubt erroneous) that they would easily be mastered in a month or two, the author covers all the material needed for the electrical questions in the entrance examinations to Universities, the First M.B., and (for candidates not taking higher mathematics), in Schedule A of the Army Examination; or, as he says, goes "probably as far as one can go without a knowledge of differential and integral calculus."

The words just quoted bring one back to that vivid impression of the rightness of the author's methods. Taking one aspect alone: although the most complicated mathematics demanded throughout the whole book is probably the bit of simple algebra on page 165, the reader is never allowed to forget that his next job, if he wants to go on from strength to strength, is to work up his "maths."—which (he will feel) he can no longer keep in its watertight compartment as a subject quite distinct from "stinks," since it is so obviously a tool needed by the physicist or engineer at every turn In fact, the reviewer can easily picture some keen young enthusiast, half-way through the book, surreptitiously searching his parents' bookshelves at half-term for the wherewithal to acquire this invaluable tool—and fortunate he will be if he finds it in that unique little book, "Calculus Made Easy," by "F.R.S." For Professor John Perry's methods would seem admirably suited to carry on the good work here begun by the Physics Master at Stowe School; the two authors, indeed, seem to have much in common—including a healthy hatred for pomposity and obscurantism. Take, for example, a quotation from the book under review: "If zinc is put in dilute sulphuric acid, 'there exists a tendency' for zinc atoms, positively charged, to leave the zinc and go into solution. That entirely unsatisfactory, and even ridiculous, statement is all that the average person is likely to get as an explanation, without a very great deal of trouble." That, surely, might have been written by the great "F.R.S." H. D.

[1] Published by Dent and Sons, Ltd. Price 4s.

Practical Hints & Tips



Simplified Aids to Better Reception.

CHOOSING S.G. VALVES.

In making a choice of ordinary triode valves one is influenced by such factors as economy in filament consumption, mutual conductance, and by their reputation as to longevity. In dealing with screen-grid high-frequency valves the same things should be taken into account, but it must not be forgotten that completeness of internal screening is a matter of great importance; unless the precautions taken to reduce anode-grid capacity to the lowest possible figure are adequate, it will be impossible to attain a very high H.F. gain, however good the "figure of merit" of the valve may be when judged by ordinary standards.

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ALTERNATIVE AERIAL SYSTEMS.

There are several ways of coupling tuned aerial and secondary circuits, each with its own advantages and disadvantages in the matter of efficiency, convenience, and economy; it is probably true to say that all the schemes applicable to broadcast receivers have been discussed at some length in the pages of this journal. As far as results are concerned, there is not a great deal to choose between the various methods, but it should perhaps be pointed out that the various practical designs that have been put forward may roughly be divided into two main groups.

In the first group we have the fully tuned aerial system, generally with a variable or semi-variable series condenser for improving selectivity, and also for extending the band of wavelength covered by a single inductance coil; this arrangement is shown in Fig. 1 (*a*). Under average working conditions it is generally the best, when judged purely by signal strength, but has the disadvantage that it is almost impossible to arrange matters so that the aerial tuning condenser remains sensibly "in step" with that shunted across the secondary inductance.

This disability can be overcome by providing an "aperiodic" coupling between the aerial and its coil in the manner shown in Fig. 1 (*b*). As ordinarily operated, this circuit should be definitely more selective than the other, but its adoption will generally result in rather weaker signals—especially if aerial coupling be reduced well below the optimum in order to maintain synchrony between the tuning condensers.

Needless to say, the (*b*) arrangement is essential when the tuning controls are to be ganged, and consequently is always to be found—though perhaps in modified form—in input filters with fixed coupling whether capacitative or magnetic.

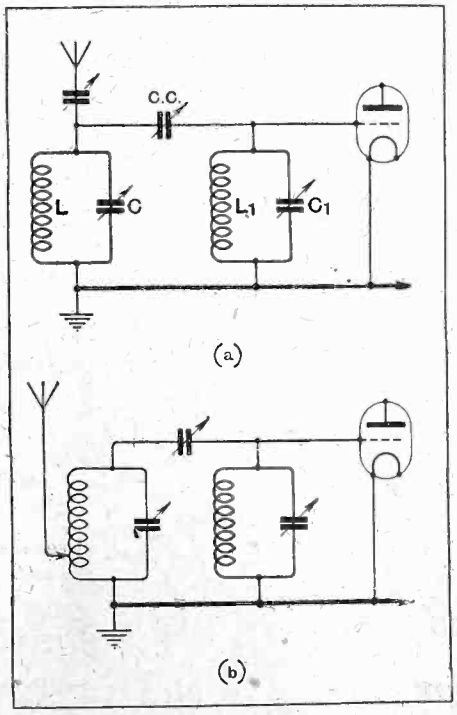

Fig. 1.—Fully tuned and "semi-aperiodic" aerial systems in conjunction with a two-circuit tuner. L, aerial inductance; L_1, secondary inductance; C, aerial condenser; C_1, secondary condenser; C.C., coupling condenser.

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SENSITIVE ANODE BEND DETECTION.

When sensitivity is the first consideration, it by no means follows that the modern type of low-impedance detector will yield best results when used on the anode bend principle, and followed by resistance coupling. Generally speaking, the best all-round performance, combined with effective detection of weak- or medium-strength signals, will be afforded by an efficient valve of fairly high impedance—from 20,000 to 30,000 ohms or even more.

A valve of this type would generally be used with an anode resistance of up to a quarter of a megohm; this value cannot be greatly exceeded without risk of impairing the reproduction of high notes.

When planning a sensitive receiver of the type under consideration, it is hardly possible to better the values used in the "1930 Everyman Four": valve impedance, 25,000 ohms, with an amplification factor of about 25; anode resistance, 250,000 ohms; anode by-pass condenser, 0.0003 mfd. These constants were chosen with a view to effecting what is generally regarded as the best possible compromise between the conflicting claims of detector efficiency, high-note loss, grid circuit loading due to reverse reaction effects, and the separation of H.F. and L.F. components in the detector anode circuit.

High-efficiency valves with impedances of from about 7,000 to 12,000 ohms have a theoretical advantage where quality is the first consideration, largely because it is possible to operate them effectively with a comparatively low value of anode coupling resistance.

A PRACTICAL INTER-VALVE COUPLING.

In this section of *The Wireless World* of July 9th it was pointed out that the Hartley detector circuit, with throttle-controlled reaction, is suitable for use in conjunction with a power grid rectifier. Casual mention was made of the fact that this arrangement can equally well be used as an inter-valve coupling in sets with H.F. amplification as in simple receivers with an unaided detector; it occurs to the writer that it may not be immediately obvious how connection should be made when there is a preceding H.F. stage.

The use of this inter-valve coupling in the form of a double-wound transformer is almost ruled out in practice by the difficulty of arranging the primary winding so that it may be properly coupled to both long- and

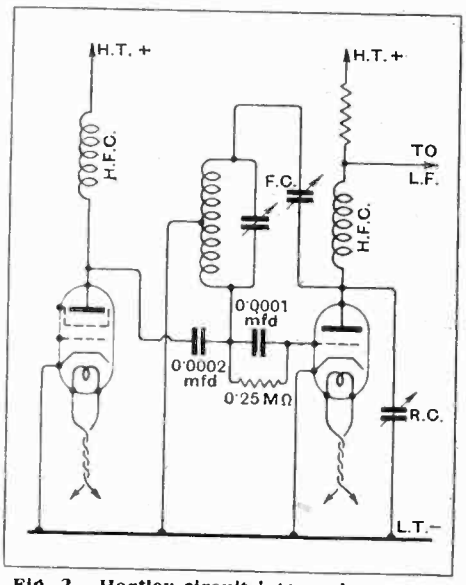

Fig. 2.—Hartley circuit inter-valve coupling between an H.F. valve and a power grid detector.

short-wave sections of the secondary coil, and to avoid all difficulties of this sort it is strongly recommended that the parallel feed or tuned grid method should be adopted in the manner suggested in Fig. 2. A consideration of this diagram will show that only one-half of the tuned inductance is in parallel with the preceding anode choke, and so the whole arrangement is more or less comparable with a 2:1 ratio step-down transformer; generally speaking, it will provide stability even when absolutely complete screening of input and output H.F. circuits is not included. This does not mean, however, that reasonable precautions should not be taken.

The diagram given in Fig. 2 does not show any provision for wave-band switching, as it merely indicates the general scheme of connections; where both medium and long broadcasting wave-bands are to be received it is generally most convenient to make provision for "loading" the tuned inductance at its centre point in the conventional manner. This is shown in Fig. 3, in which L is the centre-tapped long-wave winding, which may conveniently be a commercial coil with about 200 turns. The remaining coils are merely the two halves of the medium-wave grid inductance, which is split at its centre point.

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A MISLEADING EXPRESSION.

We have all slipped into the habit of referring to "free" grid bias, and are perhaps inclined sometimes to forget that in an art such as ours everything has its price.

Of course, apart from the initial cost of components used in providing a conventional scheme for automatic bias, the price paid is assessed in terms of lost H.T. voltage; in other words, each grid volt is obtained by sacrificing an anode volt. These volts can generally be spared, but the matter must clearly be taken into account when legislating for the supply of, let us say, an L.S.5A, which requires grid negative to the extent of over 100 volts.

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BROKEN BIAS CONNECTIONS.

Many readers seem to have been puzzled by the behaviour of receivers fitted with free grid bias, or with grid bias eliminators; in carrying out tests or adjustments of sets of this kind it is not infrequently observed that the anode current of a valve, as indicated by a milliammeter, does not undergo any appreciable change when the grid return lead joined to its bias resistance is momentarily broken. Now it is well known that standing anode current should vary in sympathy with changes of grid bias, and the effect noted above may lead one to form an opinion that the grid voltage supply device is inoperative.

In actual practice, however, this is not always the case. The grid circuits of receivers deriving their bias from the mains are almost invariably "decoupled" with fairly large resistances and condensers of considerable capacity; these condensers become charged to the working potential of the grids, and, if insulation throughout happens to be of a high order, they will retain their charge for an appreciable period of time, with the result that the operating conditions of the valve may remain sensibly unchanged, even though the bias feed circuit is interrupted.

It will therefore be clear that this effect indicates efficiency rather than inefficiency, although it should be made clear that a slight leakage, of sufficient magnitude to allow the condenser to discharge itself in a few seconds, will generally do no harm.

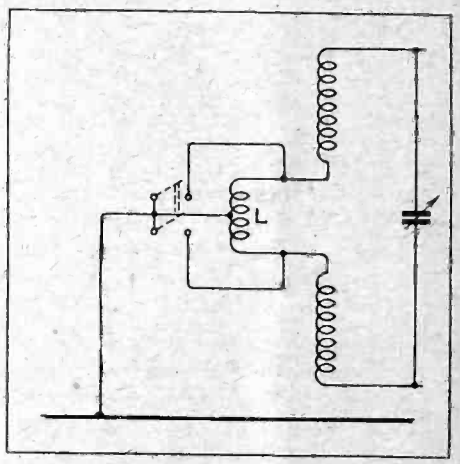
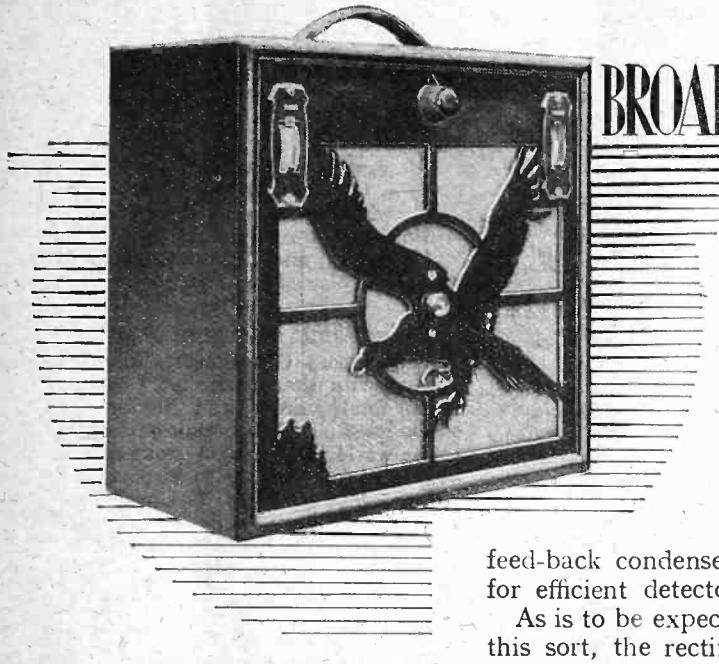


Fig. 3.—Modifying the circuit of Fig. 2 for long-wave reception.

POWER TRANSFORMERS.

Several designs for the home construction of power transformers have been published in this journal, and where an output of 4 volts for the heaters of indirectly heated A.C. valves has been provided, it has been usual to specify a winding capable of delivering 3 amperes—and accordingly intended primarily for feeding a three-valve set.

A fair margin of safety is always allowed, and the output would be adequate enough for feeding four valves without undue drop in voltage or overheating. However, when it is intended that the rated consumption is to be exceeded to this extent, it is as well, for the low-tension winding, to substitute the next heavier gauge of wire for that specified.



BROADCAST RECEIVERS REVIEWED

EAGLE "ALL-IN TWO"

A Self-contained Detector-pentode Two valve Receiver.

ONE often wonders how many listeners have sets which are, like the motor car of the classic advertisement, "too powerful for owner." A reasonable reserve of sensitivity is all to the good, but it really does seem rather ridiculous to use a five-valve set with two H.F. stages almost exclusively for the reception of a local station some few miles away. In such cases an appreciable amount of money is expended on the maintenance of valves which are rarely, if ever, called upon to do any useful work.

The set under review is primarily intended to operate on its self-contained frame aerial at a strictly limited distance from a transmitter. To cater for those who require occasional long-range reception, special provision is made for connection of an external aerial-earth system, which more or less takes the place of several expensive valves which would normally be unprofitable passengers. Alternatively, the receiver may be regarded as being a simple detector-pentode combination which is completely self-contained except for the connection of an external aerial and earth.

Its circuit arrangement embodies a grid detector joined directly across the tuned frame aerial, which is divided into two sections, one of which is short-circuited for medium-wave reception. There is capacity-controlled reaction between grid and plate circuits of this valve; the feed-back condenser is large enough for efficient detector operation.

As is to be expected in a design of this sort, the rectifier is coupled to the pentode by an L.F. transformer. The maximum available H.T. voltage of 90 is applied to both anode and screen of the output valve, but provision is made to feed the detector anode with a lower pressure. The loud speaker is directly connected, and has a fairly large by-pass condenser.

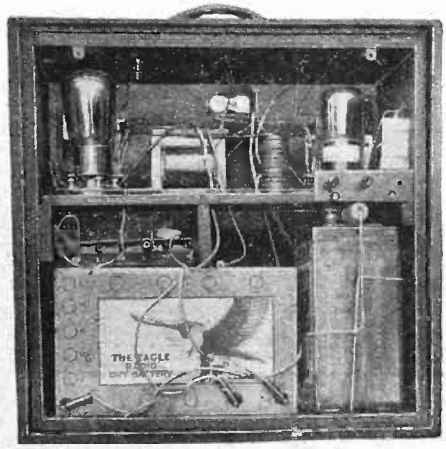
Construction is on conventional "transportable" lines, the receiver being housed in an upright oak cabinet measuring 15in. wide, 7½in. deep, and 14½in. high. The Chakophone-Colassi loud speaker is mounted in the lower part of the container, its adjusting knob being passed through the front, on which are also mounted the edgewise condenser dials; these, it is noted, are recessed sufficiently to prevent the possibility of their being damaged in transit. The remaining control is a combined filament-waveband switch.

In the instructional pamphlet issued by the makers it is stated that the set, when working on its frame aerial, should have a range of 25 miles; tests made in several localities would seem to show that this is a fair estimate of its capabilities in this direction under average conditions. True, signals are obtainable at considerably greater distances, but only at the expense of quality, because it becomes necessary unduly to press the reaction adjustment in order to obtain the necessary sensitivity. A set of this sort does not show up to best advantage when it is operated at the limit of its range, but, used under reasonable conditions it is capable of giving entirely satisfactory service.

When an aerial-earth system is added, range is, of course, increased, and the set becomes comparable with any other det.-L.F. combination. Two aerial sockets are provided, a series condenser being inserted in one of the lead-in connections to improve selectivity, and also to offset the capacity of a large aerial.

Anode current consumption is quite moderate, amounting to some 9 milliamperes when grid bias is set at 6 volts. Where economy is vital the manufacturers recommend that bias should be increased to 7.5 volts; as is to be expected, there is some falling-off in quality when the output valve is operated in this way.

The set is made by the Eagle Engineering Co., Ltd., Warwick, and is sold at nine guineas complete.



Rear view of receiver, with back cover removed.

CURRENT TOPICS

News of the Week

IN BRIEF REVIEW

FORTHCOMING EXHIBITIONS.

An International Wireless and Gramophone Exhibition is to be held at Lyons from September 6th to 14th, and the Second Rumanian Radio Exhibition will be held at Bucharest from September 7th to 28th.

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LICENCES IN CANADA.

The number of receiving sets licensed for use in Canada on April 1, 1930, was 123,557.

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SHORT-WAVE TELEPHONY IN HAWAII.

The Federal Radio Commission of U.S.A. has issued licences to the Mutual Telephone Company of Hawaii for the use of ultra short waves (5 to 13 metres) for radio telephony. Five islands of the Hawaiian group are being linked up for inter-island telephone service, which will later be expanded to connect with the projected trans-Pacific radiotelephone.

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COUNTING BEES BY WIRELESS.

We hear that a system has been devised by the Entomological Office of the American Department of Commerce whereby the exit from the hive of each worker bee is recorded by means of a microphone, amplifier, and registering needle which duly imprints its mark on a sheet of paper. The bee-master is thereby enabled to estimate the number of active workers in each hive. Our correspondent does not inform us how the microphone distinguishes between exits and entrances—possibly a system of one-way traffic has to be used—but remarks that the number of stings will still be registered by the neighbours.

BROADCASTING FROM ICELAND.

The present 1½ kW. station in Reykjavik is used almost entirely for ship service, but the new 16 kW. broadcasting station at present in the course of erection will probably be opened on October 1st and give a regular service on 1,200 metres.

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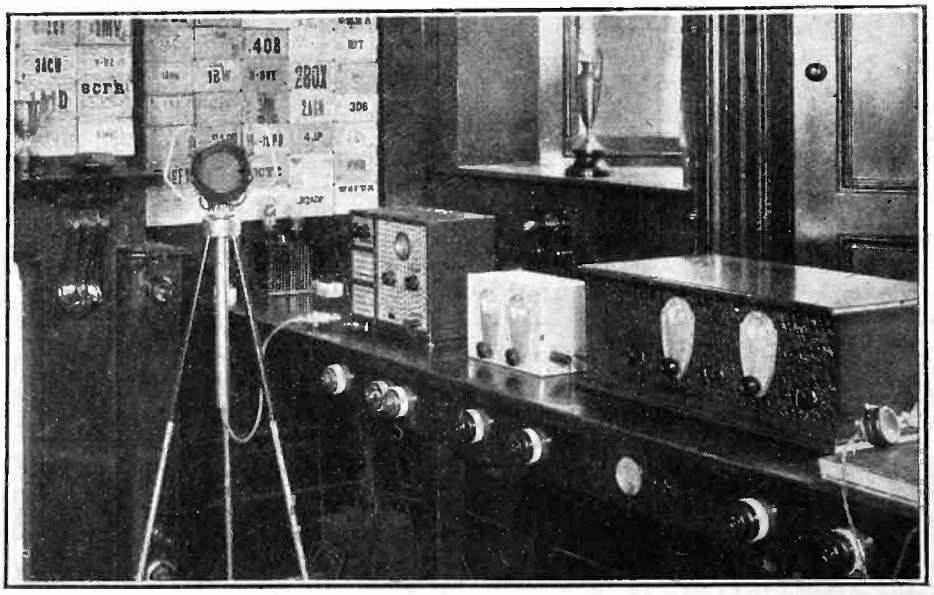
ANOTHER ARCTIC EXPEDITION.

The Rumanian Arctic Expedition under the leadership of Dr. Konstantin Dumbrava left Cherbourg (France) on July 1st last for a prolonged stay in Polar regions. With a view to establishing regular direct communication with its headquarters in Austria, it has been liberally equipped with wireless transmitting and receiving apparatus. The base will include a 200-watt transmitter to work on 23.65 and 40 metres, a small 75-watt plant to be mainly used for communication with amateur experimenters, and a 15-watt transmitter for the purpose of remaining in touch with its own aircraft on a wavelength of 65 metres. The call-sign of the Expedition is XORC, and any reports on reception of its signals should be addressed to The Second Rumanian Arctic Expedition, c/o Explorers' Club, 544, Cathedral Parkway, New York City, U.S.A.



THE FIRST ENGLISH W.A.C. Mr. H. L. O'Heffernan, whose station G5BY at Croydon is illustrated above, was the first English amateur to gain the "Worked all Continents" Certificate of the International Amateur Radio Union. He also won the Silver Cup presented by our American contemporary "Q.S.T." for the best amateur station described in its pages in 1929. We are indebted to Messrs. Philips Lamps, Ltd., in whose Public Address department Mr. O'Heffernan is an Engineer, for the photograph of his station.

NEW STATION AT STRASBOURG.

It is expected that the new station which is being erected in Strasbourg will be ready for its tests next month, and that its formal opening will take place in October.

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HIGH-POWER STATION FOR CHINA.

The Chinese Government, having contracted with the Telefunken Company of Berlin for the erection at Nanking of one of the most powerful broadcasting stations in the world, is sending a group of Chinese engineers to Germany to inspect the stations of that country. The projected station at Nanking is expected to serve the whole area of the Chinese Republic.

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EMPIRE BROADCASTING.

Overseas listeners, for some time past, have been asking the B.B.C. to supply particulars of the main items of their forthcoming programmes well in advance of their respective dates to allow of publication in the local papers of distant countries, and it is understood that the first of these advance programmes has now been issued and despatched to the Far East.

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LONG-DISTANCE CONVERSATION WITH AEROPLANE.

Telephonic communication between an aeroplane flying above Buenos Aires and the White Star liner *Majestic* while nearing the English coast was successfully accomplished over a distance of about 8,000 miles. From Buenos Aires wireless connection was made with Madrid, thence by land-line to France, and by cable to Rugby, where wireless was again employed for establishing communication with s.s. *Majestic*.

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RUM-RUNNERS' SOS.

Wireless plays a conspicuous part on both sides of the game of rum-running as practised in the United States. On the one hand, we hear of secret transmitters discovered by the Federal Prohibition agents and, on the other side, of a sham SOS stating that the yacht in which the Mayor of New York was sailing was in peril. All the coastguard patrol rushed to the rescue, leaving the coast clear for the bootleggers' agents.

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INTERNATION L CONFERENCES.

International Radio Conferences will be held in Copenhagen in 1930 and in Madrid in the following year. The first will be unofficial, but the Madrid Conference will be a meeting of all the leading nations of the world to revise and bring up to date the Radiotelegraphic Convention signed at Washington in 1927.

It is understood that, although Russia has not yet signified her intention of signing as an adherent of the International Radiotelegraphic Convention, she will be represented at both Copenhagen and Madrid.

WIRELESS THEORY SIMPLIFIED

The THREE-ELECTRODE VALVE

(Continued from page 91 of previous issue.)

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

IN order to understand clearly the meaning of the anode voltage/anode current characteristic of a valve, and to make practical use of it, it is necessary to know how the valve operates under normal conditions. This in turn necessitates a knowledge of the manner in which the potential of the grid relative to the cathode or to the negative end of the filament (according to the kind of valve) controls the anode current.

It has already been explained that the electric charge given to the grid modifies the field due to the space charge, and in this way controls the stream of electrons passing from the cathode to the anode. Suppose, for instance, that in a certain three-electrode valve the anode voltage and grid voltage are given suitable values and that the anode current is then noted. If now the potential of the grid is made slightly more positive the negative space charge will be neutralised to a slightly greater extent and more current will be allowed to flow in the anode circuit. When the grid is given a greater *negative* potential it assists the space charge in repelling electrons back to the filament and so reduces the value of the anode current.

The action of the grid is best exhibited by a curve showing how the anode current depends on the grid voltage, the anode voltage being maintained constant at some definite value during the time of measurement. It is further assumed that the cathode or filament is maintained at the normal operating temperature.

The circuit required to enable the measurements to be made is given in Fig. 1, which is the same as that of Fig. 2 in the previous part. To obtain a grid

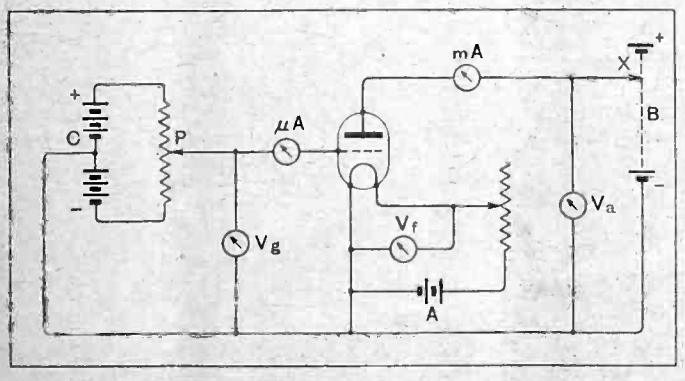

Fig. 1.—Circuit for experimental determination of the characteristic curves of a three-electrode valve.

voltage/anode current characteristic for the valve the anode voltage V_a is adjusted to an arbitrary value within the operating range specified by the makers, and the filament voltage V_f is set to the correct value. Then readings of the anode milliammeter mA. are taken for various values of grid voltage V_g adjusted by means of the slider on the potentiometer P. The voltages V_a and V_f must be kept constant during the time of taking one set of readings, but further sets of readings can be obtained with other fixed values of anode voltage V_a. There is a separate grid voltage/anode current characteristic curve for each value of the anode voltage, so that an unlimited number of such characteristic curves

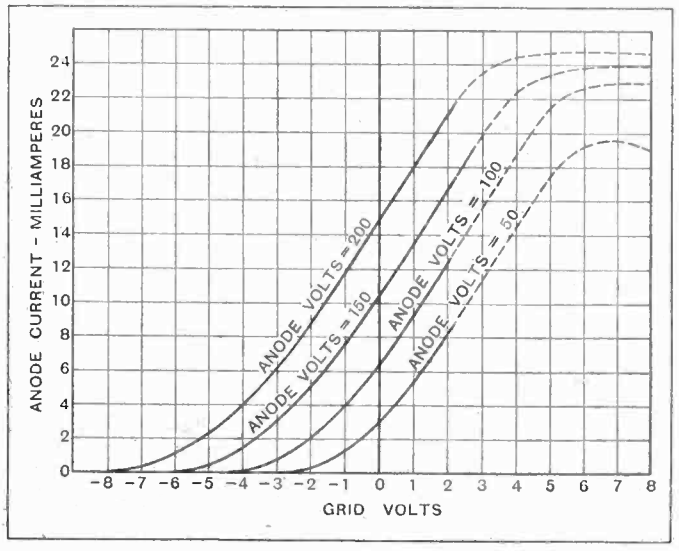

Fig. 2.—Grid voltage/anode current curves for a three-electrode amplifying valve.

can be obtained. When the valve is in use we can pick out the one which corresponds to the particular anode voltage employed.

The grid voltage/anode current characteristics of an amplifying valve with indirectly heated cathode are given in Fig. 2 for four separate fixed anode voltages as indicated on the curves themselves. The valve chosen as a representative example is one designed for an anode voltage not exceeding 200 volts. From any one of these curves it will be seen that as the grid voltage is varied from a highly negative value towards zero, that is, as the grid potential is made more positive, the anode current which is zero to begin with starts at some particular value of the grid voltage and increases, gradually at first, and then more rapidly until the curve reaches a maximum steepness. The point on the horizontal axis at which each curve begins depends on the value of the fixed anode voltage, but *each curve has approximately the same slope at its steepest part*. It will be realised at a later stage that this point is of considerable importance.

When the grid voltage is increased above zero in the positive direction each curve continues upwards

until the saturation current of the cathode is reached corresponding to the temperature at which it is being operated, so that all the curves bend over again and tend to become more or less horizontal at the top. From this it is obvious that each curve is very nearly straight at and near the point of greatest slope.

Grid Current.

So long as the grid is negative with respect to the cathode it has no attraction whatever for the free electrons moving through the vacuum. The latter are therefore allowed to pass on to the plate without any of them being trapped or intercepted by the grid. This means that for all negative potentials no current whatever will flow in the grid circuit and the microammeter μA will not indicate any current. On the other hand, when the grid is made positive relatively to the cathode it will exert an attractive force on the free electrons and a certain percentage will be attracted to and intercepted by the grid. But owing to the high velocity of the electrons which have left the filament the great majority are shot through the meshes in the grid and successfully reach their normal destination on the anode. This is provided that the positive potential of the grid is not sufficiently high to overpower the action of the anode. With comparatively high positive grid potentials and low anode voltages the grid may intercept a large proportion of the electrons, with the result that the anode current begins to fall again as the positive voltage of the grid is still further increased. This effect is clearly shown by the 50-volt curve of Fig. 2.

Nevertheless, those electrons which are intercepted by the grid are led away to the cathode again via the external grid circuit through the microammeter μA, which therefore gives a reading. Now, it will be realised subsequently that a valve does not function efficiently as an amplifier when grid current is flowing, and therefore, for amplifying purposes, the valve is always operated with the mean grid potential negative. Thus as regards the grid voltage/anode current characteristic curves of Fig. 2 we are chiefly concerned with the portions which come to the left, or negative, side of the zero.

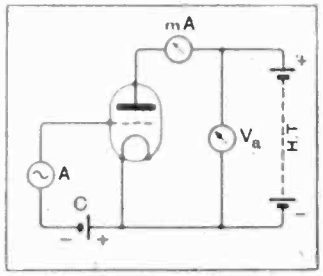

Fig. 3.—In the arrangement shown the voltage applied to the grid is made to vary periodically about the mean value determined by the "grid bias" battery C. A is a source of alternating E.M.F. The effect on the anode current is explained in the text.

Amplifying Properties of a Valve.

The normal function of a three-electrode valve in a receiving circuit is that of an amplifier or intensifier of the electrical variations representing the received speech or music. It may be employed to amplify the modulated high-frequency oscillations before they are rectified, or it may be used to amplify the audio-frequency variations after they have been separated out from the H.F. oscillations by the agency of the rectifier. The suitability of a valve for H.F. or L.F. amplification is determined by its general characteristics.

The amplifying property of a valve arises because a small change of grid potential produces a comparatively large change of voltage across a high impedance connected in series with the anode circuit. The degree of amplification obtained is determined not only by the constants of the valve itself, but also by the nature of the "load" connected in the anode circuit. One

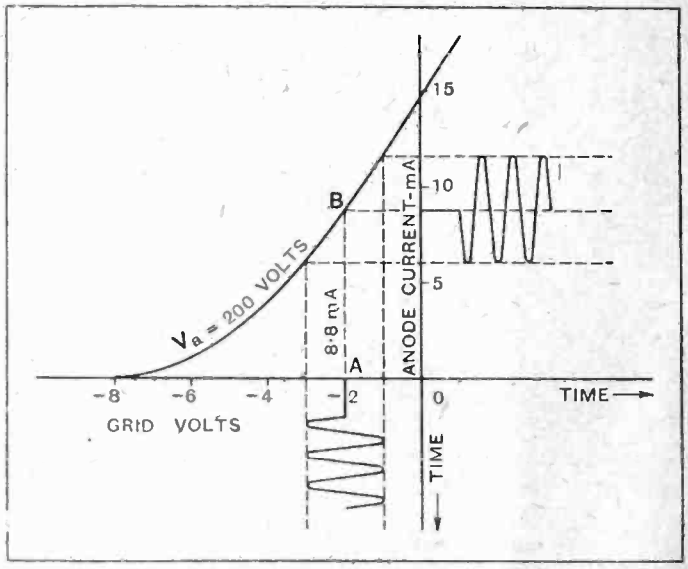

Fig. 4.—Diagram showing that a small periodic variation of the grid voltage of a three-electrode valve causes a corresponding variation in anode current. When operation occurs over a straight part of the anode characteristic the variations of anode current follow exactly those of the grid voltage.

of the most important details in the designing of an amplifier is the predetermination of the actual amplification that will be obtained with the particular valves and components used. To do this we must be able to express the characteristics of the valve itself in terms of constants derived from the static characteristic curves. The derivation and explanation of these constants will therefore be obtained with the aid of characteristic curves of an actual valve.

In the first place, then, let us see what happens when the voltage applied to the grid of a valve is made to vary periodically by a small amount above and below the mean value, the anode potential being maintained constant at a suitable figure. For instance, suppose that the valve is connected up as in Fig. 3, where C is a battery determining the mean potential of the grid relative to the filament, and A is the source of alternating voltage causing the potential of the grid to increase and decrease periodically about the mean value of bias potential.

To make the explanation consistent we shall assume that we are dealing with the same valve to which the anode characteristic curves of Fig. 2 refer and that the anode potential is maintained at 200 volts. The grid voltage/anode current characteristic curve corresponding to this value of anode voltage has been redrawn separately, and is shown in Fig. 4, there being no external resistance or impedance in the anode circuit of the valve.

Wireless Theory Simplified.—

Now, if the mean grid potential is set to such a value OA that the corresponding point B on the anode current curve occurs on the moderately straight portion as shown, any *small* change in grid voltage will cause a proportional change in anode current. No matter whether the negative grid voltage be increased or decreased by that given small amount; the change in anode current will be the same; but when the negative voltage on the grid is increased the anode current will be decreased, and *vice versa*.

Consider now what occurs when the grid voltage is made to vary periodically above and below the mean value OA by one volt. For convenience and simplicity we shall assume that variation obeys a sine law. Referring again to Fig. 4, the relationship between grid voltage and time can be seen. The mean grid potential is -2 volts, and the maximum variation is one volt above and below this, so that actually the grid voltage is "swinging" between -3 and -1 volt. Under these conditions the "grid swing" is said to be 2 volts.

Since, under the conditions chosen, the change of anode current is at every instant proportional to the change of grid voltage from the mean value, the anode current will also vary above and below a mean value (in this case 8.8 milliamps) according to a simple sine law. The graph showing the variation of anode current with time can be deduced from the other two in the manner indicated in Fig. 4. This latter graph is shown in the upper right-hand section, from which the anode current is seen to vary between 6 mA. and 11.6 mA., the mean value being 8.8 milliamps.

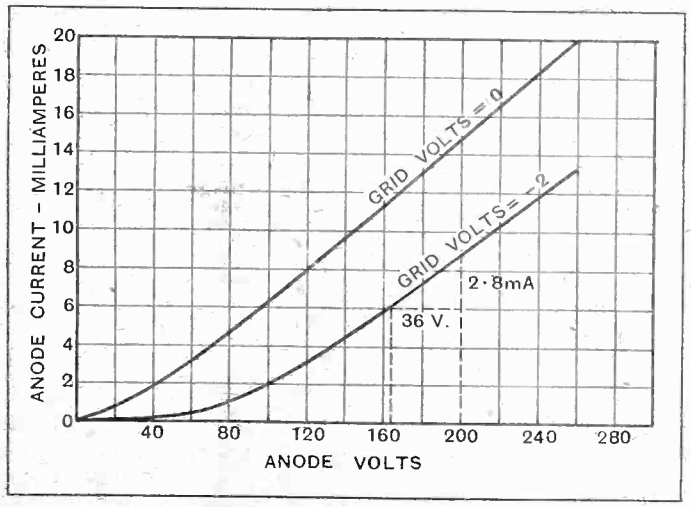

Fig. 5.—Anode voltage/anode current curves for the same valve to which Figs. 2 and 4 refer. When the grid voltage is -2 a change of 36 volts in the anode potential on the straight part of the curve changes the anode current by 2.8 mA., the change caused by one volt variation on the grid. The amplification factor is therefore 36.

Mutual Conductance.

Although under operating conditions in a receiver a valve is never used without a resistance or impedance of some sort connected in the external anode circuit, a considerable amount of information can be gleaned from Fig. 4. First and foremost, it gives us the numerical relationship between change of grid voltage and change of anode current at constant anode potential when the valve is operated on the straight portion of its anode characteristic. The ratio of the change of anode current to the change of grid voltage producing it is called the "*mutual conductance*" of the valve. In this case a change of 5.6 milliamps in the anode current is produced by a change of 2 volts in grid potential. The mutual conductance is therefore 2.8 milliamps per volt. This is really the numerical value of the slope of the anode characteristic curve at the operating point. It will be seen later that the mutual conductance expressed in amps per volt is also numerically equal to the ratio of the amplification factor to the A.C. resistance of the valve.

The Amplification Factor.

It has been shown so far that for a three-electrode valve there are two ways of varying the anode current, namely, by changing either the grid potential or the anode voltage. Two anode voltage/anode current curves for the valve we have been considering are given in Fig. 5 for grid potentials of zero and -2 respectively. Now, from Fig. 4 we find that for 1 volt change in grid potential the change of anode current is 2.8 milliamps (the mutual conductance) with the anode at 200 volts, but from the lower curve of Fig. 5, the one corresponding to the mean grid potential in use, we find that it requires a change of about 36 volts in the anode potential to produce the same change of 2.8 milliamps. *Thus changing the grid potential by one volt has the same effect as changing the anode potential by* 36 *volts*. This means that a given change of grid potential is equivalent to a much larger change of anode voltage in its effects of the anode current, and the amplifying properties of a valve arise out of this fact.

The "amplification factor," or "amplification constant," of the valve is the ratio of the change of anode voltage required to bring about a given small change of anode current to the change of grid voltage necessary to produce the same change of current. For our valve, then, the amplification factor is 36. The amplification factor is usually denoted by the Greek letter μ (mu); it is the greatest possible value of voltage amplification which the valve is theoretically capable of giving (except when a step-up transformer is used). In practice the actual direct amplification obtained is always less than μ, but can be calculated in terms of μ and the constants of the associated circuits.

(To be continued.)

BROADCAST BREVITIES

By Our Special Correspondent.

The B.B.C. Referendum.

Although the B.B.C. has hinted at the possibility of a referendum, first, to ascertain from all concerned whether the adult lectures and talks are really popular, and, secondly, to find out listeners' opinions on the timing and make-up of the programmes generally, I understand that the question how such a referendum may best be conducted is proving somewhat baffling.

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Who Should Organise the Enquiry?

Who are the statistical experts that may be called in to co-operate? Should the Central Council for Broadcast Adult Education have any part? Should even the B.B.C. itself take any part in such a referendum? It would smack rather of an *ex parte* arrangement, and there is a feeling that the organisers should be entirely free and independent.

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Would It Be Really Representative?

Again, unless it were possible to make any referendum compulsory and universal—at all events on the general programme—it would be worthless. Only extremists would probably reply, and there might conceivably be a preponderating number of votes in favour (say) of giving more time to the enjoyment of saxophones, muted trumpets and American sentimentality to the exclusion of classical music, but such voting would not represent the views of the vast majority of listeners who can appreciate both classical and light music, vaudeville and dance music, but who do not feel called upon to write to the B.B.C. on the matter.

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Striving for Perfection.

Those who heard the New York Philharmonic Symphony Orchestra before it returned to the United States must have been struck by the wonderful precision and unification displayed. The twenty or so first violins sounded like one 20 fiddle-power instrument played by one performer, and each individual group of instruments showed the same unanimity. This state of perfection can only be obtained by assiduous rehearsal, and it is the object of the new B.B.C. Symphony Orchestra to emulate or even surpass this good example.

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Expense of Rehearsals.

Rehearsals are an expensive item in orchestral work, but in this case they will be plentiful. A Symphony Concert may involve three rehearsals of three hours duration, oratorio or opera as many as four sessions each of three hours' strenuous work, while two light programmes in which the Symphony Orchestra is split up into two entirely separate bodies will probably each be given four hours' rehearsal. Most of the instrumentalists have already worked together for a long time; they are all engaged on full-time contracts, and no deputising, except in case of illness, will be permitted. We may expect, therefore, to find little lacking in the way of team work.

Talkies *v.* Orchestra.

The short note on "Talkies Oust Organ and Orchestra" which appeared in our issue of July 16th may have given the impression that the orchestra and organ of the Brixton Astoria would be entirely replaced by "Talkie" music. This is not the case, and I am informed that although the orchestra and organ will not be broadcast, they will still remain an integral part of the organisation of the Brixton Theatre.

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Another Tattoo.

The Tidworth Tattoo, one of the great military events of the year, will be broadcast in the National programme on August 5th.

FUTURE FEATURES.

National (261 and 1,554 metres).

AUGUST 3RD.—Old Contemptibles' Service, relayed from St. Martin-in-the-Fields.
AUGUST 4TH.—"Suitable Songs," Part 4.
AUGUST 5TH.—Relay from Tidworth Tattoo.
AUGUST 6TH.—Orchestral concert from National Eisteddfod of Wales (from Cardiff).
AUGUST 7TH.—"The Wedding," a farce in one act, by Anton Chekov.
AUGUST 8TH.—Vaudeville programme.
AUGUST 9TH.—Opening concert of the Promenade Concerts, relayed from the Queen's Hall.

London Regional.

AUGUST 3RD.—Orchestral programme of works by British composers.
AUGUST 4TH.—Light orchestral programme.
AUGUST 5TH.—Chamber music concert.
AUGUST 6TH.—"The Wedding," a farce in one act, by Anton Chekov.
AUGUST 6TH.—"Great Grandfather's Songbook," a Selection of Popular Songs of 1770.
AUGUST 8TH.—"Impromptu" programme.
AUGUST 9TH.—Band concert, relayed from Brighton.

Midland Regional.

AUGUST 5TH.—The "Pro Rata" Concert Party, relayed from Jephson Gardens, Royal Leamington Spa.
AUGUST 9TH.—Military Band concert.

West Regional (Cardiff).

AUGUST 4TH.—Orchestral programme relayed from the National Museum of Wales.
AUGUST 6TH.—"The Pied Piper of Hamelin," a Cantata by Sir Hubert Parry.
AUGUST 7TH.—Rt. Hon. David Lloyd George speaking at the Royal National Eisteddfod of Wales.

North Regional (Manchester).

AUGUST 6TH.—Band concert, relayed from West End Bandstand, Morecambe.
AUGUST 7TH.—Orchestral concert, relayed from Pavilion Gardens, Buxton.

Glasgow.

AUGUST 6TH.—Variety concert, relayed from Beach Pavilion, Aberdeen.

Belfast.

AUGUST 5TH.—"The Burglar who Failed," a Comedy in one act, by St. John Hankin.

Scottish Regional Station.

The Scottish Press has been actively engaged with settling, to its own satisfaction, the legal formalities involved in the B.B.C.'s purchase of a site for the Scottish Regional station, but I am able to confirm the statement made last week and say definitely that no site has yet been acquired nor is even on the point of being acquired.

The site at Falkirk is being more closely investigated than any others of those which are under consideration and, if it is found that the subsoil is suitable, that will probably be the site chosen, but if further examination reveals an admixture throughout of clay, sand and gravel or any two of these substances, it is probable that the engineers will resume their search in fresh pastures.

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Records of Historical Events.

I understand that an attempt is being made in the United States to preserve records of eventful broadcasts especially those of historical interest, but I doubt whether the scheme will prove successful. The making and preserving of suitable records is not an easy matter. Two hundred records obtained by two well-known mechanical devices used to be kept at Savoy Hill, but these were all scrapped as they were considered useless for any possible re-broadcast.

Gramophone records are, of course, used nowadays for sound effects, such as the noise of railway engines, the plaudits of a crowd, a soft orchestral background to a dialogue, or the twittering of birds. The broadcast of the nightingale, I am assured, was *not* done by this means.

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Possible Use in Rehearsals.

It seems a pity that it was found impracticable to keep suitable records of interesting events broadcast in times past if only for the sake of marking the technical progress made. Would it not be feasible and worth the expense to take a few records, at any rate of some of the leading artistes, at rehearsals so that they might hear how they "came over" and possibly correct any errors? I am told that one of the best-known of our character actors was thoroughly convinced, when he first broadcast, that his performance was a bad one. The damping effect of the studio and his own efforts to listen to himself were disconcerting, but as a matter of fact, he got over remarkably well.

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Dramatic Broadcasting: A Comparison.

The National Broadcasting Company of America has published an interesting comparison between the methods used in U.S.A. and in England. The B.B.C. as a rule uses several studios, one for the actors, another for sound effects, another for music, and so on, whereas the custom in America is to employ a single studio. Each system is considered most suitable for its particular purpose. In England radio-dramas are comparatively long and the multiple-studio is certainly preferable, but in America fifteen-minute sketches are the rule, and these are best done in a single studio.

LABORATORY TESTS on New Apparatus.

A Review of Manufacturers' Recent Products.

N. & K. FARRAND INDUCTOR.

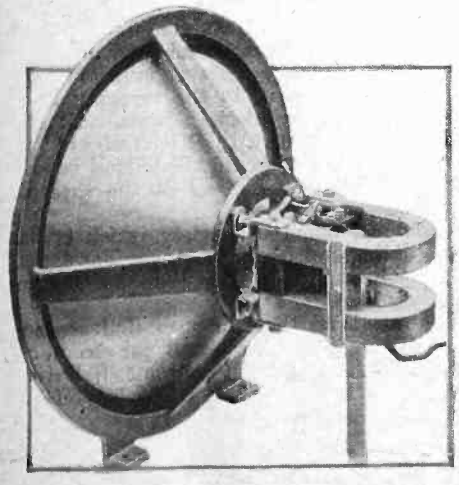
This loud speaker which is of the moving iron type employs a novel principle, and from a technical point of view is one of the most interesting recent developments in loud speaker design. The armature consists of two soft iron bars coupled by light but rigid rods, and mounted between pole pieces on two flexible phosphor bronze springs in such a way that the armature system as a whole moves in a plane parallel to the pole faces. The speech coils are wound round the laminated poles, and the variations produced in the permanent flux tend alternately to eject or attract the armatures between the air gaps.

Terminals are provided to match valves of high (3,000—6,000 ohms) and low (1,000—2,500 ohms) impedance. The measured impedances at octave intervals over the useful musical range were as follows :—

IMPEDANCE (OHMS).

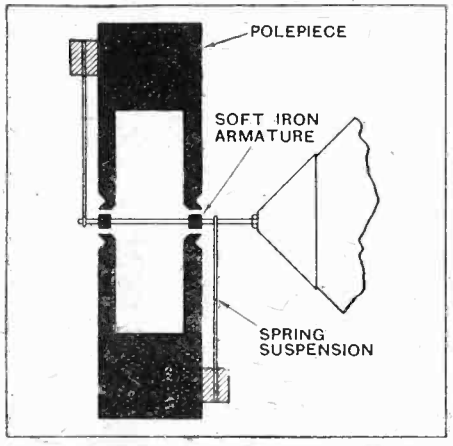
Frequency.	Series.	Parallel.
50	1,900	408
100	772	219
200	1,650	529
400	3,510	1,280
800	6,400	1,730
1,600	11,200	3,090
3,200	20,200	5,380
6,400	—	9,000

The performance is remarkable for the unusual output in the bass. The amplitudes developed at 50 and 100 cycles are even greater than those produced by the average moving coil, and are easily visible at 50 cycles. From 150 cycles upwards the output is on a lower relative level and is free from peaks, but two "valleys" occur, one at about 3,000 cycles and another of quite appreciable depth at 2,000 cycles. The acoustic output at 5,500 cycles is equal to the general level in the middle register, but there is a falling off at 6,000 cycles.



Farrand inductor loud speaker chassis.

To sum up the performance, we may say that the general effect is perhaps the closest approximation to that of the moving coil that has yet been achieved with a moving iron armature, the reason, of course, being the enhanced output below 150 cycles.



Arrangement of armatures and pole pieces in the Farrand inductor loud speaker.

Supplies are obtainable in this country from A. Brodersen, 228, Goswell Road, London, E.C.1, and the price of the chassis only is £3 12s. 6d.; in cabinet form the price is £6.

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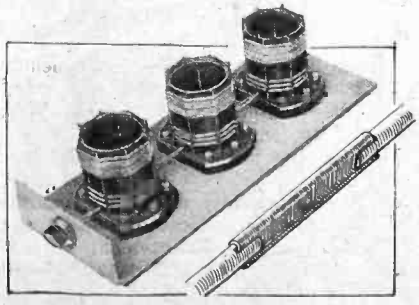
COILS FOR FOREIGN LISTENER'S FOUR.

In the recent design of the battery and D.C. operated Foreign Listener's Four, coils were used with self-contained wave change switching. The switches were operated by an ⅛in. brass rod running through bakelite bars, bearing points being obtained for this operating rod in the sides of the coils. While this form of construction involved but little difficulty it necessitated the procuring of a straight piece of ⅛in. brass rod and the fitting up of a suitable operating key.



Colvern coils for the D.C. Foreign Listener's Four, enlarged view of link shown in the sketch.

Colvern, Ltd., Mawneys Road, Romford, Essex, have now simplified the setting up of the coils by providing each coil with a brass spindle and arranging for ganging by means of slotted ends and link pieces. A switch-fitted coil is therefore supplied complete with brass spindle, one connecting link, operating key and locking ring. This form of ganged switch operation will be found particularly useful in the construction of sets where a number of tuned circuits are employed, such as in receivers embodying H.F. or band-pass arrangements. A merit of the system is that a flexibility is obtained in the connecting links which removes the need for precise alignment when positioning the coils.

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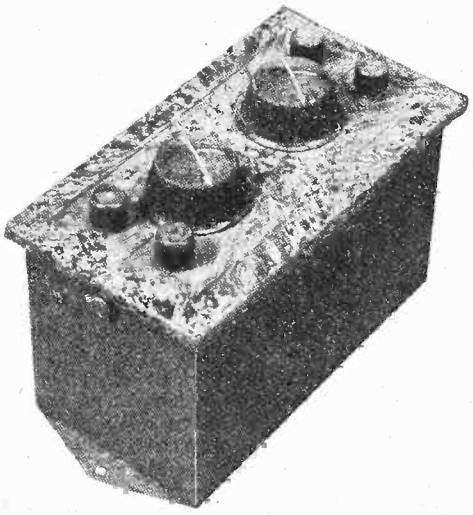
CELESTION "TILTATONE."

This unit is a combined volume control and tone corrector for use with electrical reproducing gramophones. It is connected between the pick-up and the amplifier, and special attention has been given to the question of screening and earthing. The G.B. terminal to the amplifier is connected internally to one of the pick-up terminals, so that if there is an earth connection in the amplifier there is no need specially to earth one side of the pick-up to prevent instability.



Celestion "Tiltatone" which combines in a single unit a volume control and tone corrector for electrical pick-ups.

There are two independent controls on the unit, one for volume and the other for tone. It is generally conceded that the most common fault to be found in the reproduction of the average amplifier loud speaker combination at the present time is over-accentuation of the middle register, or, put in another way, high- and low-note loss. The "Tiltatone" has therefore been designed to give a continuously variable control over the volume in the middle register without appreciably affecting either the very high or very low frequencies

On test, the tone control worked exactly according to plan, and the range of control provided should be sufficient to cope with the most flagrant cases of resonance in the middle register. A slight diminution of very high frequencies was detectable when the tone control was adjusted to give maximum suppression of the middle register, but the low-note reproduction was absolutely unaffected. The general volume control gave even distribution of the volume over the range of movement of the knob, and no reduction of high frequencies in relation to other frequencies could be detected even at the minimum audible setting.

The unit gives an overall step-up of voltage, so that less amplification is needed than when the pick-up is connected to the amplifier direct. Incidentally, the same system of tone correction has been in use in Celestion public-address systems for about three years.

The price is £4 17s. 6d., and the makers are Celestion, Ltd., London Road, Kingston-on-Thames; and 106, Victoria Street, London, S.W.1.

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.

BROADCAST PROPAGANDA.

Sir,—Although all the well-known hair restorers in the British Isles have so far failed to tune in a single new hair on my head, I still believe in the amazing power of advertising. Without it the Press of this country would practically cease to exist. The *Daily Mail* would probably shrink to the size of a lady's handkerchief and the dear old *Wireless World* to the size of four postage stamps.

Therefore, I am particularly surprised when you, as Editor, declare in your issue of June 18th that it would be a retrograde step to use the ether (by kind permission of the P.M.G.) for advertising purposes.

Competent listeners have calculated, I believe, that broadcasting is 99.8 per cent. mediocre, trivial and childish as a source of amusement. Indeed, it is exceptional for any normal person to anticipate an evening's radio enjoyment in the same way as he does when booking a seat at a theatre, or running for a bus to the nearest picture palace. We go to a show because we want to: but we listen-in—usually—because we've nothing else to do at the moment. This is bad for the reputation of the B.B.C., and very bad for us.

I suggest that it is now time that something should be done to save us from further demoralisation. The B.B.C. is particularly in need of stimulating competition and of more funds for better artists. To obtain more money from the P.M.G. would be half as difficult again as extracting red corpuscles from a piece of flint; and to charge more for the licence would be pointless if we—the listeners—can get what we want from other sources.

We can solve much of the money question and still more of the quality question immediately if only we will accept Sponsored Programmes—that is, programmes sponsored by firms or individuals who are willing to spend fabulous sums if we will but listen for a moment or two to their tale of wares.

Good, solid, bewhiskered, ancient Britons approach their sets with clubs in their hands and the spirit of destruction in their hearts at the mere thought of radio advertisements. They hear of the terrible state to which it has brought American broadcasting—and they will have none of it. They picture purveyors of pills introducing patent medicines into Chamber Music, or perverting plays by unseemly references to cures for asthma. They shudder at the thought of a foxtrot entitled "Nippy," or of a vaudeville turn by Freeman, Hardy and Willis. Although Guinness may be good for you on posters, it might be positively dangerous when served up through the ether.

The truth is, of course, that our prohibition of radio advertising is just as narrow-minded as the American prohibition of alcoholic enjoyment. The Americans see what drink has done to us, and we see what advertising has done to American broadcasting. In our distinctive ways we are both excellent examples of pious frauds. Having observed what Sharkey did to Scott, we should now be logical and say: "This is what boxing has descended to. Therefore, let us prohibit it."

The sanest way is to dally with beer and boxing, subject to certain restrictions, and to adopt the same attitude towards sponsored radio programmes.

With the London, Midland and National Stations in full working order, the B.B.C. have at last plenty of spare room in the ether for outside help (or competition). Why should they not sell for good money some of this surplus space in space? Why should not an ethereal hoarding or two be dotted across the heavenly highways? It would swell the B.B.C. funds and—still more important—add to listeners' entertainment and amusement. No advertiser would dare to put on the ether the soporific items with which the B.B.C. pad their time-tables.

To quote instances of the disfigurement of scenery with advertisement hoardings is no analogy. This does neither the motorist nor the countryside any good. If, in return, the advertisers improved the roads, tidied up the litter left by trippers, planted trees and flowers (for motorists to pick), and made the landscape better generally, then who would object to a few picturesque posters planted here and there amidst a re-beautified countryside? This is a true analogy.

A limit could be placed on the time during which a sponsor might make a few casual remarks concerning the desirability of purchasing his wares, or the danger of neglecting to partake of his pills. The method of displaying his goods could also be under supervision. We could trust the B.B.C. to do that quite efficiently!

There is no reason, too, why the sponsor should not embody in the programme a song, a short play, or a turn wherein tactful and tasteful reference could be made to the subject nearest his heart and pocket.

A play might open: "Good morning! Have you used . . . ?" And end: "Good night! And don't forget, dear, your nightcap of Vitaline. Two teaspoonfuls in half a glass of milk and you will sleep like a top, awaking refreshed in the morning . . . Good night everybody. Midland now closing down. All the staff here are trying this new nightcap . . . GOOD night!"

After three hours of real amusement, would this offend us any more than the advertisement-clad drop-curtain at the theatre, and the winking sky-signs on the way home?

Either Sponsored Programmes and that variety which is the spice of life—or the same dull round of dance music, dowagers, and drawing-room "entertainers" as dispensed by Doctor B.B.C.

Take your choice! But remember that the spoon-fed are not always the healthiest. What is an occasional jar from an advertisement compared with the present chronic irritation caused by mediocre programmes?

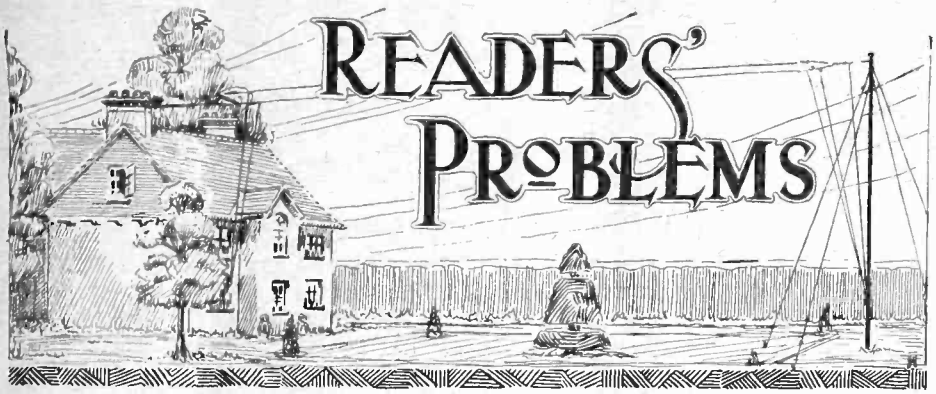
BERTRAM MUNN.

Twickenham.

REPETITION OF PROGRAMME ITEMS.

Sir,—In July 16th issue of *The Wireless World*, under the heading "Broadcast Brevities," your special correspondent makes the following remarkable statement: "It is not often, however, that an item from one station creates so much interest as to be repeated by another at a later date." I submit that many items from one of the Brookmans Park transmitters create so much (official or vested) interest as to be repeated by the other transmitter at a later date, often the following day. Indeed, one instance of this practice is foretold by your special correspondent on the very page containing the above-mentioned statement. Can such programme arrangements legitimately be called "alternative"? Personally, I think not, and am surprised never yet to have read a protest on the subject in your columns.

I enclose my card, but beg to sign myself N. GINEA.



"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Relative Efficiency.

Will you tell me if an indoor aerial with a maximum height of nearly 30ft., and with a horizontal length of 25ft., is likely to be more efficient than a frame aerial with sides of about 2ft? It is quite impossible for me to put up an outside aerial, and I wish to obtain the maximum possible sensitivity from my receiver. J. W. M.

Unless the inside aerial happens to be very badly screened by metal work in close proximity to it, there can be no doubt that it will be more efficient as a collector than a frame aerial of the dimentions given.

o o o o

Coil Terminals.

When reference is made to the "lower end" of a coil, should it be understood that the expression refers to the low-potential end of the inductance in an electrical sense, and not to its physical position? O. M. N.

Unless the context makes it quite clear that reference is being made to the physical positions of the extremities of the coil, it is quite safe to assume that a statement of this sort relates to the A.C. voltage distribution along the winding Colloquially, the end of an inductance that is connected either to filament or to the source of H.T. voltage supply is generally called the lower end.

o o o o

Fieldless Chokes.

I have noticed that many of your contributors of published designs for receivers seem to prefer the use of binocular H.F. chokes in the anode circuit of the detector valve. Is this a matter of great importance? Unless there is any objection, I propose to use an ordinary section-wound choke (of a good make which has been favourably reviewed in your columns) in the construction of my new 2-v-1 receiver. P. N. M.

A choke with a restricted external field is very often used in a 2 H.F. receiver (particularly when a high-magnification H.F. amplifier is employed) because it might otherwise be difficult to prevent stray coupling between the choke which is in the detector anode circuit and other inductive windings.

If you take care to see that all possibility of these stray couplings is avoided, there is no reason why your existing choke should not be used.

o o o o

H.F. Stopping Resistances.

In receivers designed for the normal broadcast wavebands, H.F. stopping resistances of from 0.1 to 0.25 megohm are often inserted in series with the grids of the L.F. amplifying valves. Would it not be correct to use a considerably lower value of resistance when building a short-wave receiver? G. C. E.

These H.F. stoppers operate by virtue of the ratio between their resistance and the reactance of incidental grid-filament capacities in the valve: as the reactance of these stray capacities is very much less when ultra-short wavelengths are being dealt with than in a receiver designed for normal frequencies, it follows that the usual values could, as you suggest, be reduced appreciably. However, a series grid resistance of, say, 0.1 megohm is not likely to cause any appreciable high note loss, and we think it would serve no useful purpose to reduce its value much below that figure.

o o o o

Volume Control Affects Tone.

The volume control which is connected to my pick-up is effective in so far as it enables me to reduce intensity to any desired level, but when its knob is set in the "weak" position there is a distinct lowering of tone and reproduction is lacking in brilliancy. Do you think that matters could be improved by using some other form of control, and, if so, will you suggest the best method? H. R.

It seems certain that your volume control is in the form of a variable resistance in shunt with the pick-up windings; for reasons that have been discussed at length in the pages of this journal, it is a fact that this method may introduce serious attenuation of the upper frequencies.

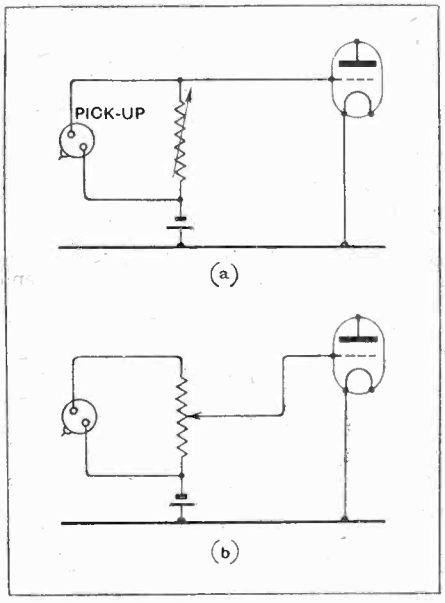


Fig. 1.—Volume control for a pick-up. High note loss introduced by a shunt resistance (a) may be avoided by substituting a potentiometer (b).

In Fig. 1 (a) we show what is probably your present scheme of connections; in Fig. 1 (b) is given an improved method which makes use of a potentiometer which should have a resistance of at least 100,000 ohms.

o o o o

Reducing Screening.

I am about to build a receiver on the lines of the "Band Pass Four," but, as it is, if possible, to be mounted in an existing cabinet, I should like to reduce its overall dimensions slightly. Do you consider that it would be permissible to use rather less comprehensive screening than in the original model as described? N. N. E.

We would dissuade you from attempting to make any radical alteration in this respect, although it might be possible to avoid the use of a screening box for the first tuned input circuit components.

RULES.

(1.) A query must be accompanied by a COUPON removed from the advertisement pages of the CURRENT ISSUE.

(2.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(3.) Queries must be written on one side of the paper and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(4.) Designs or circuit diagrams for complete receivers or eliminators cannot ordinarily be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(5.) Practical wiring plans cannot be supplied or considered.

(6.) Designs for components such as L.F. chokes, power transformers, complex coil assemblies, etc., cannot be supplied.

(7.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World"; to standard manufactured receivers; or to "Kit" sets that have been reviewed.

High Note Loss.

Although my new receiver is working quite well, I am not altogether satisfied with the quality of reproduction. The trouble seems to be most marked on speech—perhaps because I have not a good musical ear. "S" sounds do not seem to be properly reproduced, with the result that speech is sometimes difficult to follow.

Can you give me any idea as to what is likely to be wrong?

M. C. M.

It is very probable that "high note loss" is taking place in your receiver; this is almost always indicated by poor reproduction of sibilants. The trouble may be traced to the H.F. amplifier and tuning circuits, where it can be caused by undue sharpness of tuning. Equally, the L.F. side of the set may be at fault, and effects of this sort are generally attributed to the use of excessively high anode resistances, of unduly large by-pass condensers, or even to the presence of excessive stray capacities in anode circuits.

There remains the possibility that, due to interstage reaction, the L.F. amplifier is giving excessive proportional amplification of a fairly low frequency.

If you care to send us a circuit diagram of your set, with values marked on it, we will endeavour to make a definite suggestion, but before going further, we would advise you, if possible, to make a test with another loud speaker.

o o o o

A Composite H.F. Amplifier.

I am thinking of making up a two-stage H.F. amplifier with an S.G. valve and a neutralised triode, using for the latter the coupling transformers which have already stood me in good stead in a set with a single H.F. stage. In what order would you advise me to use the two valves?

R. P.

This is a nice point and, except from considerations of selectivity, there should be little difference whichever way the stages are arranged, at any rate if you intend to use double-wound transformers for both of them

We think that the selectivity of the set will be rather better if the aerial input is fed to the neutralised triode, and so we recommend you to adopt this scheme.

o o o o

Pick-up Connections for the Band Pass Four.

If it is possible to do so, will you please show me how to connect a gramophone pick-up to the Band Pass Four receiver?

If possible, I should like to retain the feature of free grid bias, and will, of course, make provision for switching off the H.F. valves when the set is being used for gramophone reproduction. P. B.

This set works quite well as a radio gramophone, provided that a fairly sensitive pick-up is used. In addition to providing a switch for interrupting current supply to the H.F. valve heaters, it will be necessary to insert a single-pole double-throw switch in the detector grid circuit, arranging its connections in the manner shown in Fig. 2. When the H.F. valves are switched off the flow of current through the original bias resistance R_{12} will be reduced, bringing about a consequent reduction in bias; accordingly it will be necessary to provide an extra bias

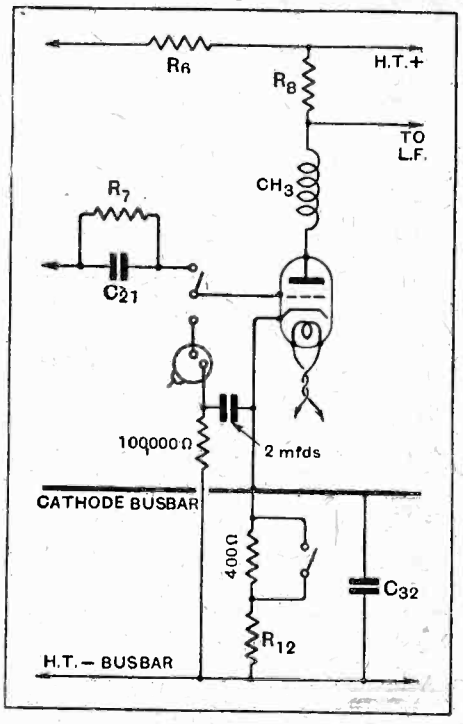


Fig. 2.—Detector grid circuit of the "Band Pass Four," modified for insertion of a gramophone pick-up.

resistance as shown. This resistance must be shunted by a switch in order that it may be short-circuited when the set is used for its normal purpose of receiving radio signals.

To avoid complexity in drawing, separate switches are shown, but there is no reason why they should not be combined in a single instrument.

o o o o

Insufficient Range.

Do you think that the "Power Pentode Two" ("The Wireless World," May 7th) would be sensitive enough for use in this locality?

From my experience with other det.-L.F. receivers, I have no doubt that it would be possible to obtain quite loud signals, but I am uncertain whether it would be possible adequately to load the power-grid detector valve. N. C. L.

We see that you live at a distance of about seventy miles from the nearest station, and in these circumstances we do not consider that the "Power Pentode Two" is sufficiently sensitive to provide consistent reception combined with the high quality of which a receiver of this kind is capable.

As you suggest, there should be no difficulty with a large aerial in getting signals of a sort, but it is certain that, to "fill up" the detector—even if it were possible to do so, which we doubt—it would be necessary to make excessive use of reaction. A stage of H.F. amplification seems to be clearly indicated.

o o o o

Total Anode Current.

Will you please tell me how to connect a milliammeter (which is normally used to indicate output valve overloading) in such a way that it will show the total anode current consumed by all the valves in my receiver? E. T. W.

This is quite simple: all you have to do is to connect the milliammeter between the H.T. negative terminal of the set and the negative terminal of the H.T. battery or eliminator.

We should add the warning that unless the various anode circuits are properly decoupled it is just possible that the insertion of the meter (which will have an appreciable resistance) may provoke self-oscillation, as this resistance is common to all anode circuits. The trouble will not arise if a proper system of decoupling is employed.

It will hardly be necessary to say that a measuring instrument inserted in this position will also show the screening grid current of any S.G. valves that may be included in your set.

FOREIGN BROADCAST GUIDE.

BELGRADE

(Yugoslavia).

Geographical Position: 44° 47′ N. 20° 26′ E.

Approximate air line from London: 1,055 miles.

Wavelength: 432.3 m. Frequency: 694 kc. Power: 2.5 kW

Time:* Central European (one hour in advance of G.M.T.).

* *B.S.T. coincides with C.E.T.*

Standard Daily Transmissions.

09.00 B.S.T. (Sun.) relay of Sacred Service from the Cathedral; 10.30 gramophone records; 12.20 luncheon concert and news; 18.00 talks; concert; 20.00 main evening programme.

Female announcer only. Call: *Hallo! Hallo! Radio Beograd.*

Opening announcements are made in the Serbian, German, French and English languages.

Interval signal: Metronome (1 beat per second). The hollow sound is somewhat reminiscent of an Indian tom-tom.

Station usually closes down at about 23.00 with words *Laki Noc* (Good night) and, if at full hour, with clock chimes and carillon.

Belgrade frequently relays Vienna broadcasts and takes in the International programmes transmitted by Austria, Germany, Hungary, Czechoslovakia and Poland. On some evenings transmissions are S.B. from Ljubljana and Zagreb.

MISCELLANEOUS ADVERTISEMENTS.

NOTICES.

THE CHARGE FOR ADVERTISEMENTS in these columns is :

12 words or less, 2/- and 2d. for every additional word.

Each paragraph is charged separately and name and address must be counted.

SERIES DISCOUNTS are allowed to Trade Advertisers as follows on orders for consecutive insertions, provided a contract is placed in advance, and in the absence of fresh instructions the entire "copy" is repeated from the previous issue : 13 consecutive insertions 5% ; 26 consecutive, 10% ; 52 consecutive, 15%.

ADVERTISEMENTS for these columns are accepted up to FIRST POST on THURSDAY MORNING (previous to date of issue) at the Head Offices of "The Wireless World," Dorset House, Tudor Street, London, E.C.4, or on WEDNESDAY MORNING at the Branch Offices, 19, Hertford Street, Coventry ; Guildhall Buildings, Navigation Street, Birmingham ; 260, Deansgate, Manchester ; 101, St. Vincent Street, Glasgow, C.2.

Advertisements that arrive too late for a particular issue will automatically be inserted in the following issue unless accompanied by instructions to the contrary. All advertisements in this section must be strictly prepaid.

The proprietors retain the right to refuse or withdraw advertisements at their discretion.

Postal Orders and Cheques sent in payment for advertisements should be made ~~& Co.~~ payable to ILIFFE & SONS Ltd., and crossed ~~& Co.~~ Notes being untraceable if lost in transit should not be sent as remittances.

All letters relating to advertisements should quote the number which is printed at the end of each advertisement, and the date of the issue in which it appeared.

The proprietors are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes.

NUMBERED ADDRESSES.

For the convenience of private advertisers, letters may be addressed to numbers at "The Wireless World" Office. When this is desired, the sum of 6d. to defray the cost of registration and to cover postage on replies must be added to the advertisement charge, which must include the words Box ooo, c/o "The Wireless World." Only the number will appear in the advertisement. All replies should be addressed No. ooo, c/o "The Wireless World," Dorset House, Tudor Street, London, E.C.4. *Readers who reply to Box No. advertisements are warned against sending remittance through the post except in registered envelopes ; in all such cases the use of the Deposit System is recommended, and the envelope should be clearly marked "Deposit Department."*

DEPOSIT SYSTEM.

Readers who hesitate to send money to unknown persons may deal in perfect safety by availing themselves of our Deposit System. If the money be deposited with "The Wireless World," both parties are advised of its receipt.

The time allowed for decision is three days, counting from receipt of goods, after which period, if buyer decides not to retain goods, they must be returned to sender. If a sale is effected, buyer instructs us to remit amount to seller, but if not, seller instructs us to return amount to depositor. Carriage is paid by the buyer, but in the event of no sale, and subject to there being no different arrangement between buyer and seller, each pays carriage one way. The seller takes the risk of loss or damage in transit, for which we take no responsibility. For all transactions up to £10, a deposit fee of 1/- is charged ; on transactions over £10 and under £50, the fee is 2/6 ; over £50, 5/-. All deposit matters are dealt with at Dorset House, Tudor Street, London, E.C.4, and cheques and money orders should be made payable to Iliffe & Sons Limited.

SPECIAL NOTE.—Readers who reply to advertisements and receive no answer to their enquiries are requested to regard the silence as an indication that the goods advertised have already been disposed of. Advertisers often receive so many enquiries that it is quite impossible to reply to each one by post.

IMPORTANT NOTICE.

Owing to the August Bank Holiday, the next issue of "THE WIRELESS WORLD" (dated August 6th) is closing for press earlier than usual.

In accordance with the Notice that appeared last week, the latest date upon which Miscellaneous Advertisements could be accepted for the above issue was FIRST POST, WEDNESDAY, July 30th.

ACCUMULATORS—BATTERIES.

ZINCS.—Best quality (wired), No. 1, 8d. per doz.; No. 2, 9d. per doz.; orders valued 5/- carriage paid, otherwise 6d. for postage.—British Battery Co., Clarendon Rd., Watford, Herts. [0258

ACCUMULATOR HIRE.

DON'T Buy Accumulators or Dry Batteries, join our C.A.V. low- and high-tension accumulator hire service, the largest and best in London; better and cheaper reception with no trouble; regular deliveries within 12 miles of Charing Cross; no deposit, payment on each delivery or by quarterly subscription; over 10,000 satisfied users; explanatory folder post free; 'phone or write to-day.—Radio Service (Loudon), Ltd., 105, Torriano Av., N.W.5. 'Phone: North 0623-4-5. [8751

RECEIVERS FOR SALE.

SCOTT SESSIONS and Co., Great Britain's Radio Doctors.—Read advertisement under Miscellaneous. [0264

HIRE a McMichael Portable Set, by day or week, from Alexander Black, Wireless Doctor and Consultant, 55, Ebury St., S.W.1. Sloane 1655. [0328

MAGNIFICENT Cabinet Set, 36in. high, absolutely modern 6-valve superhet, drum dials, complete with frames, valves, cone, loud-speaker, high and low tension accumulators, and high tension charger, a most efficient set and in perfect order, in Jacobean oak cabinet, space for books and papers; £12.—6, Lancaster Park Rd., Harrogate. [1083

McMICHAEL Screened Dimic Three, as new, extra coils for ultra short waves, 20/100 metres; £15.—Swallow, The Beacon, Newport Rd., Sandown, I.W. [1080

HALCYON Portable De Luxe 5-valve Cabinet, as new; cost 37 guineas, accept 18 guineas.—Apply Cecil, 91, Houndsditch, E.C.3. [1079

ALL-BRITISH Six Wireless Set, complete in cabinet containing Celestion loud-speaker, will work off frame or outside aerial, 40 stations, 6 valves; £8.—L. C. A. D., 18, Berkeley St. Mayfair 7050. [1071

G.E.C. 2S.G. World Wide Four, frame aerials, Kabilok cabinet, M.C. speaker, accumulators; £27, cost £50; exchange A.C. radiogram.—Box 6952, c/o *The Wireless World.* [1065

FOR Sale, 5-valve Pye portable set, 2 extra accumulators, nearly new, guarantee unexpired; owner leaving for U.S.A.; 15 guineas, or near offer.—Box 6922, c/o *The Wireless World.* [1062

LOOK! Manufacturers stock!!—Complete 3-valve A.C. and D.C. all main sets, 110-220v., quality component; easy terms; £10.—96, Brockley Rise, S.E.23. [1081

BERCLIF D.C.2 All Mains Receiver, 200 to 250 volts D.C.; price £14/10; with valves and royalties, suitable for M.C. speaker; particulars free; trade inquiries specially invited.—Simmonds Bros., Shireland Rd., Smethwick. [8734

YOUR Old Receiver or Components Taken in Part Exchange for New; write to us before purchasing elsewhere, and obtain expert advice from wireless engineer of 25 years' professional wireless experience; send a list of components or the components themselves, and we will quote you by return post; thousands of satisfied clients.—Scientific Development Co., 57, Guildhall St., Preston. [0226

MARCONI 5-valve Portable, model 55, walnut, new, complete; for £12/10.—Taylor, 110, Goswell Rd., E.C. [1086

Receivers for Sale.—Contd.

APPLEBY'S.

WHERE Radio Part Exchange Began; a service under the patronage of notabilities and men of consequence all over the world which has accurately handled the requisitions of over 25,000 people, 84% of whom have repeated their first transaction.

THE Service is as Follows: We can supply practically all the leading lines of radio apparatus on the market at current list prices; if so desired we can accept in part exchange the reputable makes of the following apparatus: Receivers (domestic and portable), radio-gramophones, loud-speakers (cone and moving coil), cone units and chassis, battery eliminators and mains equipment components, battery chargers, remote control equipment, pick-ups and carrier arms, electric gramophone motors, H.F., L.F., and power chokes, condensers (variable, reaction, by-pass and smoothing), measuring instruments (high grade), L.F. transformers, slow motion dials (high grade), modern miscellaneous components; valves and tuning coils cannot be accepted in part exchange except by special arrangement

IN View of the Difficulty of Making Fair and Definite Offers for Material that we have not inspected, it is requested that apparatus tendered for part exchange be kindly forwarded to us for valuation; no business can be proceeded with in connection with part exchange until material tendered has been examined; in this connection there need be no fear, material is sent to us from all over the world, not a single item of customers' property has ever been lost or mislaid; rejected offers from Xmas last amount to only 3.

IN Order to Furnish a Guide, the part exchange allowance may be gauged as approximately 50% of the list price of the article or articles tendered; for some articles the allowance will be more, and for others somewhat less; the allowance is entirely determined by the demand for individual articles, considering also their condition and production age; amateur constructed receivers cannot be accepted in part exchange as receivers, their value lying wholly in the components contained in them; only modern apparatus in good condition is accepted in part exchange; material cannot be purchased by us for cash.

TERMS of Part Exchange Business: A minimum of 50% of the value of an order, plus carriage charge where due, is payable in cash, unless the value is below £1, when a minimum of 10s. is payable; should the part exchange allowance exceed 50% of the total value of new requirements, the difference will be credited against future orders; material may be deposited against a credit note, which may be utilised at a later date; the maximum amount allowed to stand to the credit of any one individual is £200.

THESE Terms Have Been Made to the Lowest Economic Minimum, to give the customer the best value possible, while enabling us to maintain the standard required of this business.

SPECIAL Notice is drawn to the fact that by stipulating a minimum of 50% cash payable on part exchange orders, which is the same as stating that the part exchange allowance is credited to an order for not less than twice the allowance, you are ensured always of the best offer, as obviously the more we allow you the more you ultimately spend with us, to utilise your credit, if for no other reason; note also the facility of depositing material against a credit note, it can be drawn upon as required, wherever you may be; credit notes worth many thousands of pounds have been duly honoured upon presentation; a credit note on Appleby's is saleable, should the necessity arise, providing notice of transference is lodged with us at the time of sale.

AS Soon as Apparatus is Discarded from Use, dispose of it, don't keep it; it is not only wasteful, but expensive; the longer you keep it the older it is, and the older it is the less value it is; exchange it for a part exchange credit note, the value of which is constant, and can be disposed of if necessary by the holder with greater ease and facility than an article or collection of articles can ever be.

YOU Will Do Well to Deal with Appleby's; there is more in part exchange than the mere allowance; there is that something which begets confidence, that care that makes for efficiency; in the recent words of an old customer: Quite an embarrassing aloofness of purpose and an almost monotonous accuracy; you will know that it is all British—British capital and British behaviour; you will know also by dealing there that you are helping to employ British people.

SINCE the Day This Service Started it has Steadily Grown, not on rash advertising or subscribed capital, but on the volume of attainment only; and in these days businesses do not grow by that means for nothing, therefore we are privileged to invite you to utilise this service, wherever you may live; if you send your material by a carrier, pack it well, carriers are only human, and it is better to be safe than sorry; if you live in London, call to see us, you will like the atmosphere, it savours more of sport and art than the searing curriculum of commerce.

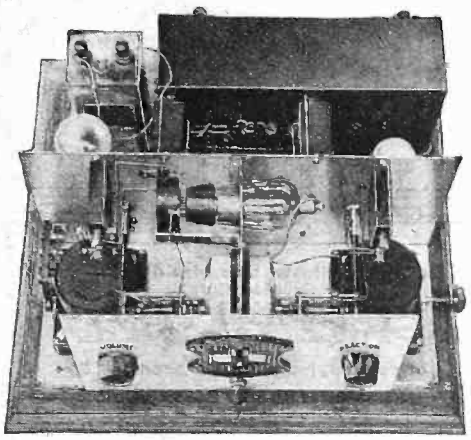
APPLEBY'S, Chapel St., St. Marylebone, London (opposite Edgware Rd. Metropolitan Station, or 4 minutes from Marble Arch, Oxford St.). Tel.: Paddington 8828 (5 lines). [0340

CHARGERS AND ELIMINATORS.

CHESTER BROS.—All types of mains transformers and chokes to any specification.—Chester Bros., 244, Dalston Lane, London, E.8. [9798

TANTALUM and Lionium for A.C. Rectifiers; for inexpensive chargers; blue prints for H.T. and L.T., 1/- each; Lionilum electrodes, 2-3 and 5-8 amps.—Blackwells Metallurgical Works, Ltd., Garston, Liverpool. [8298

Success is assured!



Build the Lotus S.G.P. Battery Set.

The success of a set depends on the efficiency of each individual component. The Lotus S.G.P. Battery Kit uses the famous Lotus Components, each one of which works in complete harmony with its neighbours. This remarkably efficient 3-valve set is simple to build: all the main components are already mounted in position to save you time and to ensure success.

Full diagrammatic details supplied with each Kit.

Price: £7-12-6 (excluding valves, cabinet and batteries) or 14/9 down and 11 similar monthly instalments.

Full details on request.

LOTUS

3-VALVE SET KIT

Garnett, Whiteley & Co., Ltd.,
(Dept. W.W.9)
Lotus Works, Mill Lane, Liverpool.

Causton

Chargers and Eliminators.—Contd.

PHILIPSON'S Safety High Tension Supply Units for A.C. and D.C. Mains, 200-250 volts 40-60 cycles, also 230 volts 25 cycles.

10/- Down and Small Monthly Payments Secures the Finest H.T. Supply Available.

PHILIPSON'S Safety H.T. Units are Guaranteed for 12 Months Against All Defects.

ALL Models Sold on 7 Days' Approval to Ensure Complete Satisfaction.

PHILIPSON'S Safety H.T. Units are the Cheapest to Install and the Cheapest to Run; £1/17/6 to £6.

WRITE for Our Booklet, "Radio Power," which gives illustrations and full particulars.

PHILIPSON'S Safety Loud Speaker Output Filters for All Receivers, power valve, or Pentode; a remarkable output filter at a very low price; 16/6.

PHILIPSON and Co., Ltd., Radio Engineers, Astley Bridge, Bolton. 'Phone: 2038 Bolton. [0318

ELIMINATOR Kit Ready for Wiring.—The Westinghouse 20 milliamp, 120 volt model kit consists of transformer, choke, Westinghouse rectifier, 8 mfd.'s of condensers, 2 resistances for S, G, and detector.

SUPPLIED, screwed to baseboard and safety plugs and sockets mounted.

CRACKLE-ENAMELLED Metal Case is Supplied Ready to Screw to Baseboard.

ONLY Requires Wiring to Drawing Supplied, and can be used within 15 minutes.

GUARANTEED for 12 Months, and sent on 7 days' approval against cash; no risk whatever; the postage is paid, and the whole outfit ready to wire is 60/-.—Fel-Ectric Radio, Garden St., Sheffield. [9963

ELLISON MANFG. Co., Ltd., for better value in soundly constructed and designed mains equipment; write us for quotations for any size or quantity of transformers or chokes; special prices for quantities.

THIS Week's Special Lines: Transformers for H.T.3 metal rectifiers, 200, 230, 250 volts A.C. input, 135 volts 20 milliamps output, 15/-.

FILAMENT Heating Transformers, universal input 4v., 5a. output, can be used with confidence with 3, 4 or 5 one amp. valves, as regulation is exceptionally good; only 19/6.

LISTS and Quotations from the Ellison Manfg. Co., Ltd., Dragon Works, Harrogate. 'Phone: 4680. [1072

EKCO All Power Unit, C.I.A., D.C., £9/15 list, as brand new, unpacked; £6.—Martin, 3, Belfield Rd., Didsbury, Manchester. [1063

B.T.H. Tungar L.T. Charger, 220 volts, 40-50 cycles, output 15 volts 2 amps., good condition; cheap.—Iverson, 17, Cavendish Rd., London, E.4. [1061

TRANSFORMERS: Ready Power London.—Transformers and chokes for eliminators and chargers; the best and cheapest British made; list free.—Lallemand, 5, Charles St., Hatton Garden, London, E.C.1. [1030

SAVAGE'S Specialise in Wireless Power from the Mains; reliable apparatus at reasonable prices.

SAVAGE'S.—Transformer laminations and Bakelite bobbins; intending home constructors should write for list.

SAVAGE'S.—Reliable smoothing condensers, 1,500 volt D.C. test, 1 mfd., 2/-; 2 mfd., 3/-; 4 mfd., 5/3; 500 volt D.C. test, 1 mfd., 1/6; 2 mfd., 2/3; 4 mfd., 3/9.

SAVAGE'S.—Super smoothing and output chokes, many types available; write for list.

SAVAGE'S.—Mains transformer for Westinghouse H.T.4 unit, with additional winding, 4 volts centre tapped 3 amps, 23/-; transformers for other Westinghouse units available.

SAVAGE'S.—Mains equipment for new Foreign Listeners Four, transformer N.F.L.4, 33/-; smoothing choke, C32G, 20/-; output choke C32O, 20/-.

SAVAGE'S.—Mains equipment for Power Pentode Two transformer, P.P.2, 33/-; output choke, L.C. 36P.G., 19/6; smoothing choke, L.C.36G, 18/-.

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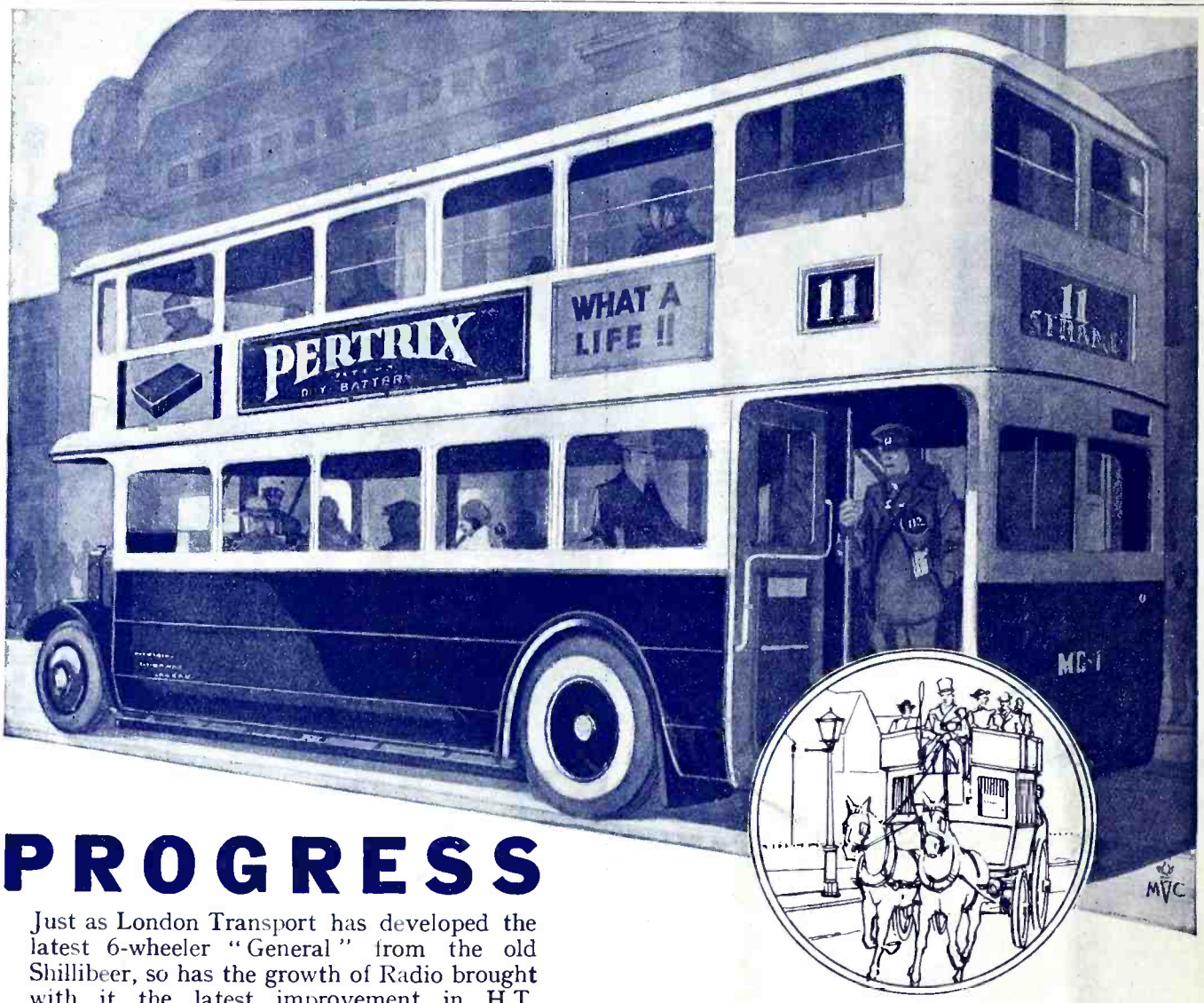

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