WATCHING THE DIAPHRAGM VIBRATE

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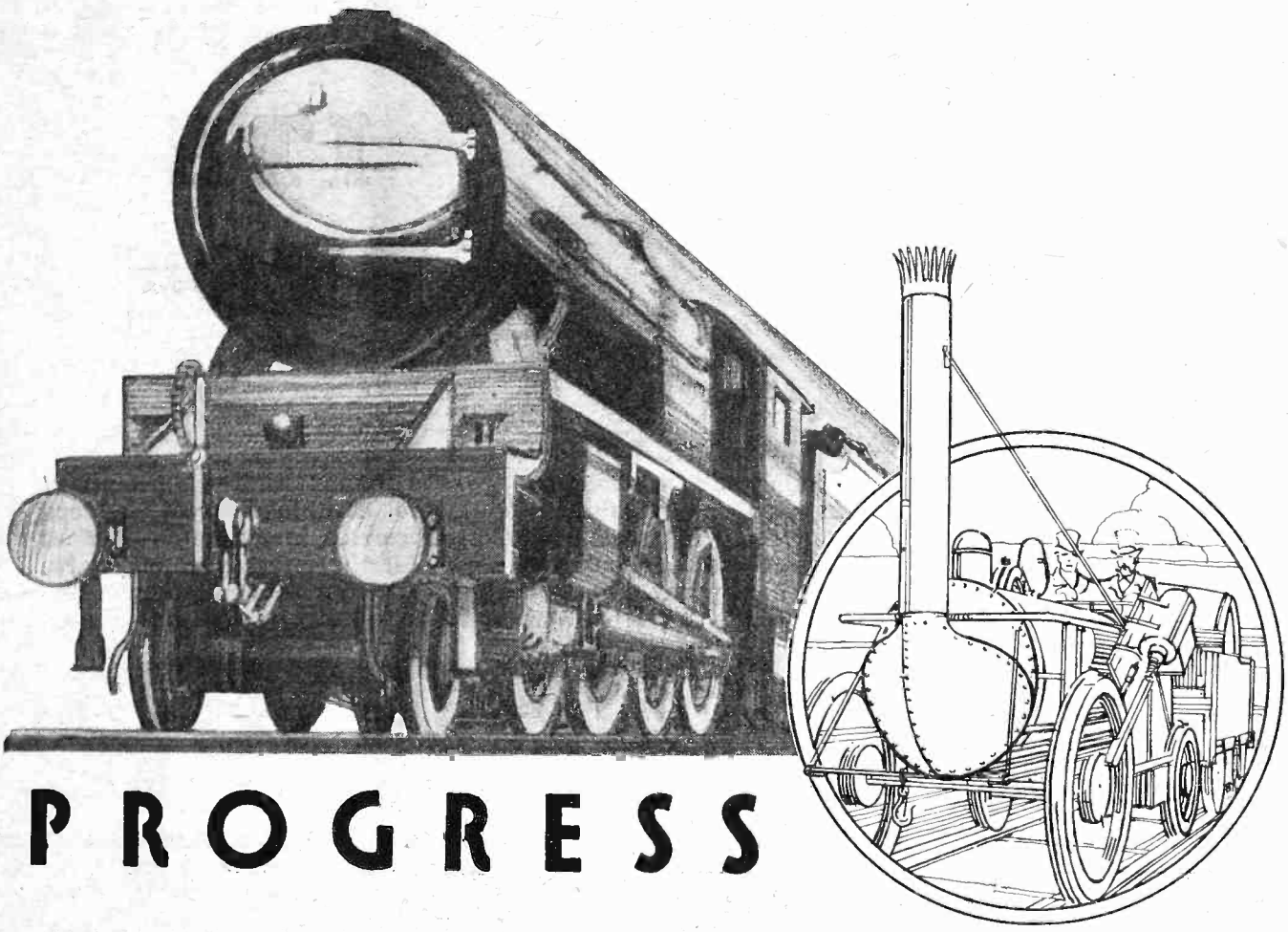
The Wireless World

AND RADIO REVIEW

The Paper for Every Wireless Amateur

Wednesday, July 23rd, 1930.

No. 569. Vol. XXVII. No. 4.



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The Wireless World AND RADIO REVIEW

(18th Year of Publication)

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VALVE PRICE REDUCTION.

AS we go to press with this issue the welcome news reaches us that the British Radio Valve Manufacturers' Association has agreed upon an all-round reduction in the price of British receiving valves, this reduction to include all but a few of the newest types.

Readers will recollect that the last substantial price reduction in valves followed on a campaign conducted through *The Wireless World* in 1927. During the intervening period we have not felt that a further reduction could fairly be demanded, in view of the very great changes which have been taking place in valve technique, necessitating on the part of the valve manufacturers a large amount of experimental work which is extremely costly and unproductive until the ultimate design is finally decided upon. It is, therefore, the more gratifying to find that the present price reduction has come about sooner than we had expected.

We understand that the reduction dated from Friday, the 18th, so that those readers who may have had occasion to buy valves during the last few days may already have experienced the satisfaction of paying approximately 2s. or 2s. 6d. less for their valves than they have been accustomed to pay in the past.

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MAN-MADE STATIC.

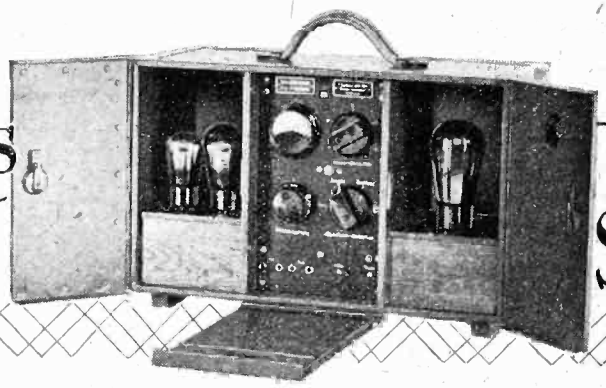
CORRESPONDENCE in this issue under the title of "Interference with the Reception of Radio," raises anew the question of control over sources of artificial interference which hampers radio reception. It is recognised that it is almost impossible to eliminate interference of this nature at the receiving end and, therefore, we are dependent upon those controlling the source of interference to effect a remedy.

When Parliament, in 1925, considered a short Bill relating to wireless telegraphy which was drafted with the idea of clarifying the position of authority of the Postmaster-General, we well remember that a clause included in the Bill, which would have given the Postmaster-General control over the radiation of electrical energy, provoked such an outcry that that clause was eventually dropped before the Bill became law. We recollect, too, that at that time we supported the objections to the inclusion of the clause because it was generally felt that the Postmaster-General's powers ought not to be extended to the control of electrical energy which might have nothing to do with the telegraphic or telephonic communication monopoly of the Post Office.

Progress in general electrification and the expansion of broadcasting in this country has served to bring home more forcibly than ever the necessity for some sort of control over what is fast becoming a nuisance, particularly in some less fortunate areas. The Postmaster-General apparently admits that he has "no statutory powers under which he could compel the owner of an electrical plant causing interference with wireless reception to remove the cause of the interference," since this statement is quoted from a letter from the Engineer-in-chief to Mr. James Nelson, who communicates to our correspondence columns in this issue.

We know that the B.B.C. is taking active steps in the spirit of co-operation and persuasion to endeavour to bring about a reduction of interference where this is due to avoidable causes, but if persuasion fails to have the desired effect, is it not time that some form of legislation should be introduced to control such causes of interference with reception now that broadcasting may be regarded as one of the common amenities of life?

Some Applications of Ultra Short Waves



Experiments in Transmission and Reception below 10 metres.

By DR. F. NOACK.

THE earliest investigations made in Germany into the practical application of the ultra-short waves (below 10 metres) were carried out by Professor Esau, of the University of Jena, whose work met with considerable success. His experiments were primarily directed towards determining the suitability of ordinary transmitting valves for ultra-short wave work, and towards finding a convenient mode of raising the power and of modulating for telephony. He paid some attention also to the problems of reception on these wavelengths, and to the range attainable, though in this latter connection he restricted himself to comparatively short distances.

Using Professor Esau's experiments as a starting point, Messrs. C. Lorenz, of Berlin, are engaged in a comprehensive series of experiments on the design of apparatus for making practical use of these ultra-short waves. Part of the work is being carried out with the assistance of Professor Esau, and part in conjunction with the Radio division of the German Aerial Research Institute (Professor Fassbender).

Several organisations are interested in the use of ultra-short waves. The chief of these, besides the aircraft companies, are the railways, the army, the navy, and, to a certain extent, the telegraph service.

Previous experiments have shown that the ultra-short waves behave much like light waves in their mode of propagation, in that their radius of action only extends to the horizon. The range can therefore be increased if the transmitter or the receiver is raised high above the surface of the earth.

From the experiments already carried out it seemed likely that ultra-short waves, like light, follow the inverse square law, and it had been shown that they could be refracted like light. Further, obstacles of every kind appeared to produce shadows. To determine whether these conclusions were really applicable to the propagation of the ultra-short waves, experiments were undertaken from an aeroplane. For this purpose the transmitting and receiving apparatus shown in the title illustration and Figs. 1 to 3 were used. The two parts were enclosed in water-tight boxes, which also contained the microphone amplifier for telephony and the receiving amplifier. The transmitter had a power of 1 to 2 watts in the aerial; the receiver was of the super-regenerative type with a two-stage low-frequency amplifier.

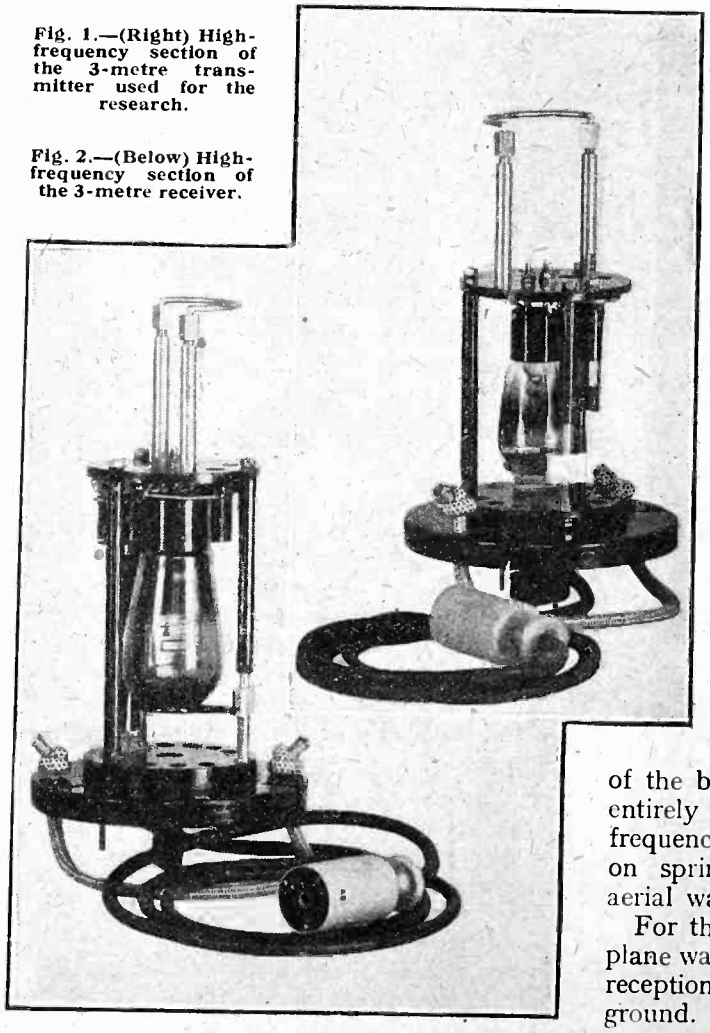


Fig. 1.—(Right) High-frequency section of the 3-metre transmitter used for the research.

Fig. 2.—(Below) High-frequency section of the 3-metre receiver.

A Junkers aeroplane (cabin type) was used for the investigation. The transmitter was attached by springs to the outside of the body, while the receiver was entirely within the cabin, the high-frequency portion being fixed, again on springs, to the window. No aerial was used at any time.

For the first experiment the aeroplane was used only for transmission, reception being carried out on the ground. The range attainable with

Some Applications of Ultra Short Waves.—

the aeroplane flying at a fixed height of 1,000 metres was determined, and it was found that the signal strength was R8 to R10 up to 30 km., but fell off rapidly after that distance, signals disappearing completely when the transmitter had flown to a distance of 50 km. from the receiver. At distances up to about 10 km. the signal strength was unchanged by varying the height of the aeroplane from 100 metres to 12,000 metres. Below 100 metres the signals fell off, and vanished altogether below 30 metres.

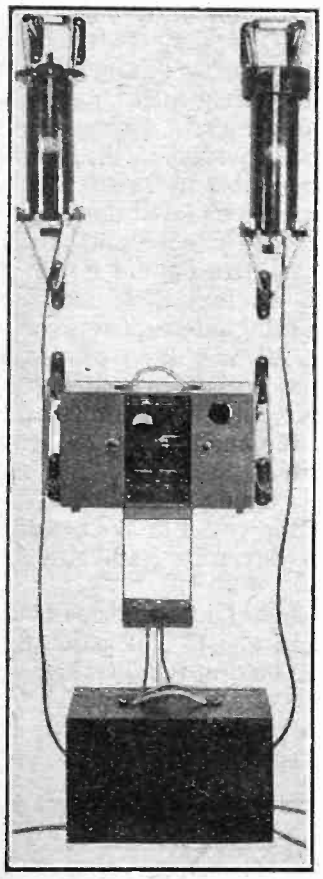


Fig. 3.—The 3-metre transmitter (left) and receiver (right) used for two-way working. Above is the high-frequency equipment hung on springs, and below the amplifier and battery boxes.

On account of the need to operate tuning and reaction controls, difficulties were found in receiving in the aeroplane if the receiver was taken outside the machine. Besides this, the noise of the ignition caused great interference, though only when the motor was starting; at full throttle good reception was possible.

At a height of about 100 metres the first telegraphic signals were received at a strength of R4 to R6 at a range of about 10 km. Reception frequently faded out at lesser distances, but this can be attributed to screening by the aeroplane itself. Reception on the aeroplane was also found to fall off when flying below 100 metres, and to vanish completely below 30 metres. No difference was observed between telephony and telegraphy.

The power of the transmitter was obviously not sufficient when aeroplanes built largely of metal were used. As a consequence further flights of the same kind were undertaken, for which a 70-watt transmitter, using a dipole aerial, was erected on a tower in Jena.

The flight was carried out between Berlin and Nuremberg and the transmitter was first heard at a distance of 45 km. from Jena and at a height of 600 metres, the signal strength being R4 to R5. At a height of 1,000 metres the strength was R9 to R10. On flying farther for a distance of 50 to 80 km. the signals remained approximately constant in strength, but at 100 km. they vanished completely. On the return flight the transmitter was first heard at a range of 40 km. at a height of 500 metres. Reception could be continued to a distance of 90 km. beyond the transmitter, although the aeroplane was flying at only 350 metres. At a greater range than 90 km. signals were no longer appreciable.

It is to be noticed that reception only began when the aeroplane was broadside on to the transmitter, and was at its best as the aeroplane flew away from it. This phenomenon is accounted for by the screening produced by the lower plane which, situated below and in front of the cabin in which the receiver was placed, came between receiver and transmitter as the aeroplane approached the latter.

The results observed certainly seem to bear out the theory just outlined: reception is seriously upset by the effects of screening.

Further Series of Experiments.

A second investigation was made, in conjunction with Professor Esau, by placing another transmitter of higher power on the peak of the Brocken, in the Harz Mountains, at a height of 1,140 metres above sea-level (Figs. 4 and 5). Reception was best north-east of the Brocken, where the country is more or less flat, and from whence the peak can always be seen. According to the theory, the possible range should be about 110 km.

For the transmitter a Telefunken valve, type RS229g, was used, and the wavelength was 3.2 metres, transmitting taking place from a vertical dipole aerial 1.6 metres long. The receiver was that which had already been used in the aeroplane. Reception could be carried out without any aerial, or with a horizontal aerial 2.5 metres long, or with a vertical aerial of length about 8 metres.

At first the transmitter was erected at ground level on the Brocken. The range was 76 to 100 km., and within this distance the signal strength was practically constant. Beyond this distance it decreased with extraordinary

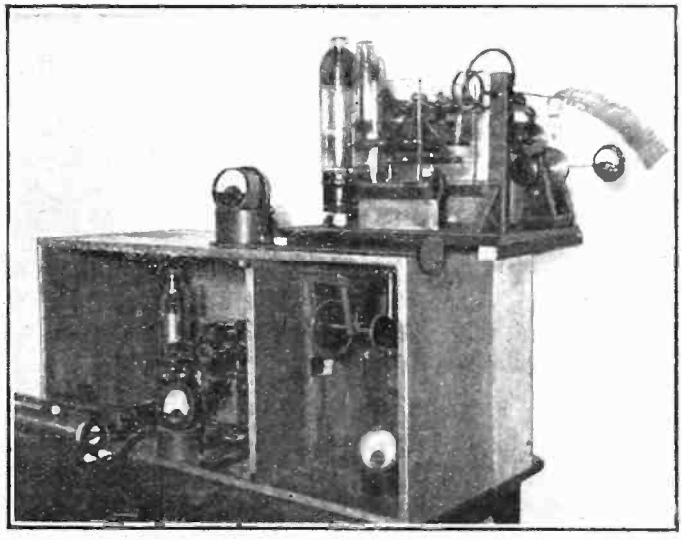


Fig. 4.—Separately controlled 6-metre transmitter with a power of 600 watts.

rapidity, the width of the region over which this rapid decline took place being from 6 to 15 km. It is to be assumed that in this region (the "boundary region") reception is no longer carried out by the aid of direct radiation, but depends on indirect refracted rays.

In further experiments the power of the transmitter was altered, in steps, over a total range of 80 to 1. In this way it was shown that up to a distance of 70 km. reception was always possible, whatever the power used,

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though the signal strength naturally varied. At distances greater than 79 km. from the transmitter the signal strength fell away rapidly, and at distances greater than 85 km. reception was only possible with the highest power in use. This series of experiments shows that the range of ultra-short waves does actually conform to the theory given above, and is mainly determined by the distance of the horizon. In consequence, the power used by the transmitter has but a small influence on the range attained.

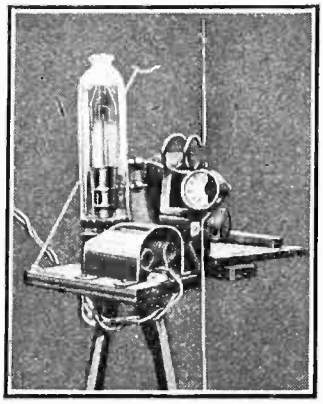

Fig. 5.—The powerful 3-metre transmitter erected on the peak of the Brocken. The dipole aerial is shown.

For a further series of experiments the transmitter was put on the stone tower which stands on the peak of the Brocken. In one direction it was found possible to show a gain of 20 km. over the previous range.

It is interesting to note that the use of an aerial for reception resulted in practically no improvement in signal strength. This, however, only applies to the region within which the radiation from the transmitter was received directly. In the "boundary region," where reception is apparently due to refracted, and not to direct, rays, a small increase of range could be attained by connecting up an aerial. This increase amounted to about 25 per cent. of the range possible by reception of the direct rays.

As a further test of the theory another series of experiments was undertaken, the transmitter being placed about half-way up the Brocken, at a height of 500 metres above sea-level and about 350 metres above the surrounding country. The transmitter was placed on a tower 16 metres high so as to cut out as far as possible the effects of the proximity of the ground. The range within which the signal strength remained approximately constant was about 66 km., while at 77 km. reception faded out entirely. Again it was found that it made no difference whether an aerial was used or not.

Experiments Confirm Theory.

All the results of these researches are in more or less good agreement with the theory that has been given. The importance of this fact for the practical applications of the ultra-short waves is very great, for, as is now quite clear, the range of the direct ray depends entirely upon the elevation of the transmitter and the receiver. To what extent long ranges depending on refraction in the Heaviside layer can be attained with ultra-short waves is a matter that has not yet been fully investigated. It would naturally be of great importance if indirect rays did not arise in the same way with ultra-short waves as with those of greater wavelength, for then any results that might be found possible would be absolutely reliable. It is true that Alexanderson, in America, has found that long-range reception attributable to refraction in the Heaviside layer can be attained, for his transmitter has been heard in South America. It would appear, however, that refraction only takes place in a north-and-south direction, determined, it would seem, in some way by the magnetic field of the earth.

Many Applications for Ultra-short Waves.

The results which have been attained during the experiments described show that the ultra-short waves have certain distinctive properties. They have a range which, as the theory already discussed shows, is readily controlled; they are largely independent of disturbances, whether atmospheric or of local origin; they are free from fading, on account of the absence of a refracted ray; they can be modulated at very high frequencies, and they are very readily made highly directional. Hahnemann, of the Lorenz Company, consequently suggests the following applications as particularly suitable for these characteristics: It would appear always to be advisable to put the transmitters on towers, and one might perhaps put three reflectors and three transmitters on the top of a tower, as suggested in Fig. 6, so that three separate beams are radiated, each beam being interrupted according to some signal in Morse. If any kind of vessel comes into the beams there is at once the possibility of directing it as from a lighthouse. If, for example, the Morse signals chosen are for the middle section, two dashes, for the right-hand sector, three dots, and for the left-hand sector a dash alternating with three dots, it at once becomes possible for the vessel to keep within the middle sector, and so to direct its path straight towards the tower.

In a similar way two beams could be transmitted from a ship, one pointing to port and one to starboard, the two transmitters sending out, as before, different signals in Morse. In this way a substitute is provided for the vessel's lights that would be of great value in foggy weather. Hahnemann suggests that ultra-short

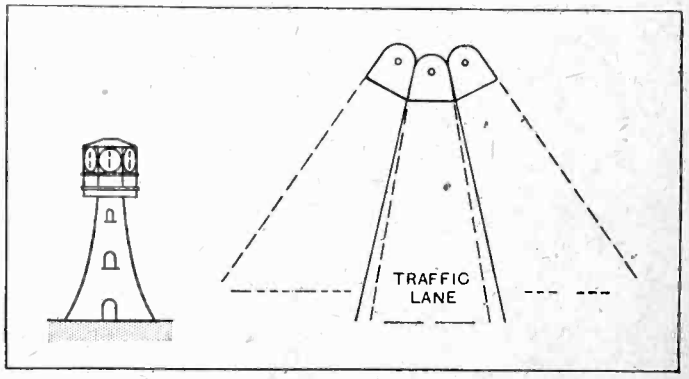

Fig. 6.—Radio-Lighthouse using ultra-short waves as an aid to navigation.

waves will also find application to aeroplanes, and is of the opinion that they may eventually replace trunk lines for inland telegraphy. It would only be necessary to erect towers at suitable distances apart (see Fig. 7) and to fit each with two directional equipments pointing in opposite directions, one to be used for transmission and the other for reception. A tower of this kind would act as a relay. The separation between the towers, and their height, would be chosen according to the range

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required. The ultra-short waves offer the possibility of a very sharply defined beam, so that high efficiency could readily be obtained. Complicated and unreliable amplifiers can therefore be avoided. Hahnemann further points out that ultra-short waves offer unusual possibilities for multiple telegraphy and telephony on the one basic wave, in which the several modulating waves are superimposed on the basic wave, and each of the modulating waves carries a different telegraphic or telephonic message. The ease of modulating the ultra-short waves at very high frequency is alone enough to permit a multiple application of this. The sharpness of a directed beam, together with the erection of both transmitters and receivers on towers, should make unauthorised listening practically impossible, so that the requirement of secrecy should be amply met.

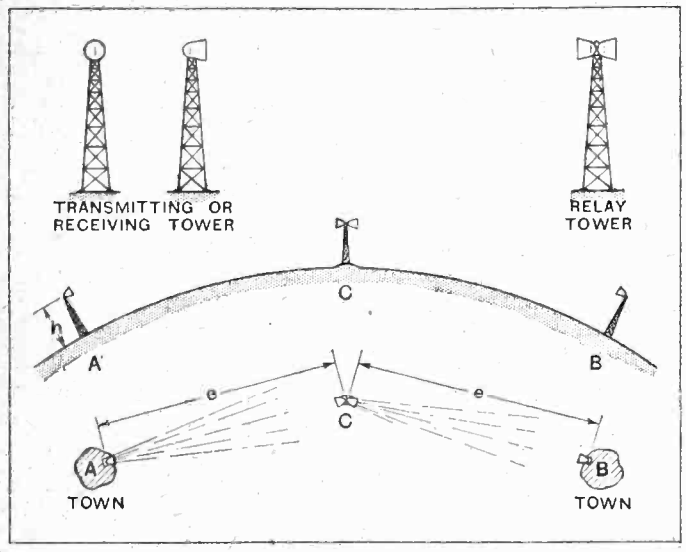

Fig. 7.—Arrangement of a line of beam station relays for ultra-short waves.

Hahnemann has only suggested a few applications. It is known to the writer that attempts have been made to introduce ultra-short waves into railway working for communication between the driver of the train and the rest of the staff on board. It is said that the results have been most encouraging.

On the technical side so much progress has been made that properly designed transmitters and receivers are available. It therefore seems justifiable to assume that it can only be a matter of time before the ultra-short waves find considerable practical applications.

Practical Hints and Tips.

TESTING LOW-TENSION A.C. CIRCUITS.

The four-volt low-tension circuits of receivers with indirectly heated A.C. valves are not particularly susceptible to troubles, but nevertheless, occasion sometimes arises for testing their continuity and for assuring one's self that the appropriate sockets of each valve are receiving the necessary voltage. It is useful to remember that a flashlamp bulb, of which the voltage rating is approximately correct, can be used as a test lamp or indicating device. A suitable holder for these lamps, to which a pair of flexible leads may be connected, is obtainable for a few pence.

By noting whether the lamp is glowing at normal brilliancy, it is possible to form a very good idea as to whether the voltage delivered by the heating transformer is reasonably correct.

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A QUICK CONDENSER TEST.

Various simple methods of testing the insulation of fixed condensers, and even of forming a rough idea as to whether their capacities are substantially correct, have been put forward, but unfortunately most of them take a certain amount of time to put into execution. Now in a modern mains receiver there may be about two dozen of these components, in various capacities, and an extended test of each of them is a lengthy business. A good idea as to the insulation resistance of a condenser may quickly be obtained by noting the effect of making successive contacts across its terminals when using the phones-and-battery method. On first closing the circuit, a click, depending in intensity on the capacity of the condenser, will be heard, but when it is fully charged to a potential equal to that of the testing battery, no click should be audible.

If clicks of approximately the same loudness occur at each contact, it can definitely be assumed that the insulation resistance of the condenser is at least poor, or even that it has completely broken down. Of course, before making the test, one should assure oneself that there is no parallel path for current, and if necessary disconnect one of the terminals.

INSTABILITY ON LONG WAVES.

When a set with an S.G. high-frequency valve or valves is instable on the long-wave band, but performs satisfactorily when medium wavelengths are being received, the trouble is generally attributed to the action of H.F. currents in the L.F. amplifier. It is a fact that the usual arrangements for separating H.F. and L.F. components in detector anode circuits become less and less effective as wavelength is increased, and so this conclusion is often justifiable. But it must not be forgotten that the trouble may almost equally well be due to falling-off in the effectiveness of "decoupling" devices; the working value of the resistances used in these systems remains constant irrespective of wavelength, but the reactance of the associated condensers increases rapidly with increase of wavelength. Consequently, the filtering action of these devices becomes less effective as wavelength is increased, and long-wave instability may quite possibly be due to stray couplings brought about by voltages set up in the common source of anode current supply, whether it be a battery or an eliminator The remedy, of course, is to fit considerably larger bypass condensers.

Practical Hints and Tips.—

THE BASE LINE.

Theoretical diagrams of mains-driven receivers are getting almost alarmingly complicated, or at any rate they appear to be so on casual examination. Their complexity is, perhaps, rather more apparent than real, as most difficulties will disappear if the circuit is mentally divided

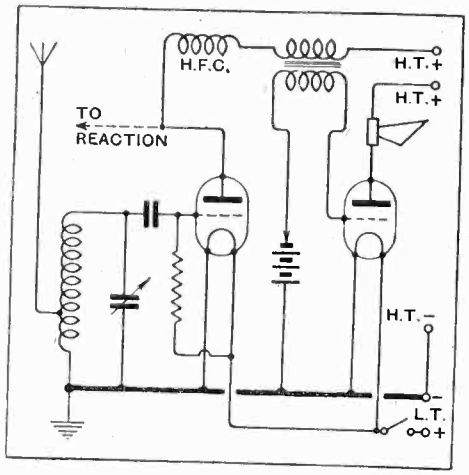

Fig. 1.—By drawing the earthed L.T. negative H.T. negative busbar as a heavy line, a clear starting point for tracing individual grid or plate circuits is provided.

into its component parts—H.F. amplifier, detector, L.F amplifier, and eliminator—but even then there may sometimes be need for a wet towel when one is called upon to tackle the theoretical representation of, say, an elaborate A.C. mains set with free grid bias—which addition is perhaps the villain of the piece, and responsible for many of our perplexities.

To make matters easier, some contributors to these pages have prepared their circuit diagrams with a heavy base line, which will serve as a "point of departure" in tracing out the individual plate and grid circuits of each valve. This seems to be a move in the right direction, and may even be helpful when dealing with comparatively simple battery sets. The principle is illustrated in Fig. 1, which is the circuit diagram of the simplest possible two-valve det.-L.F. receiver. In this case the base line is the common H.T. negative-L.T. negative busbar, which is almost invariably earthed. Even if it is not (a metallic connection between filaments and earth is undesirable, for example, in a D.C. mains set), this busbar should still be regarded as the base line around which the rest of the circuit is built up.

In the diagrams of sets with indirectly heated A.C. valves and without "free" grid bias, the base line is obviously the busbar to which all cathodes and the H.T. negative input are connected. When free grid bias is added there is a tendency to regard the H.T. negative connection as the starting point, but this is likely to lead to confusion, and so it is best still to regard the cathode connection as the base line, remembering that bias voltage will be developed across the resistance joined between one or more cathodes and the H.T. negative terminal. This is indicated in Fig. 2, which represents an imaginary receiver circuit in which bias for the H.F. and output valves is taken from a potentiometer inserted in the low-potential end of the common anode circuit. As is usual with indirectly heated valves, the grid detector works with a zero grid.

In studying a diagram of this kind it is convenient at first to ignore everything but the "signal frequency" part of the grid circuit; thus we should consider that these parts of the H.F. and L.F. amplifying

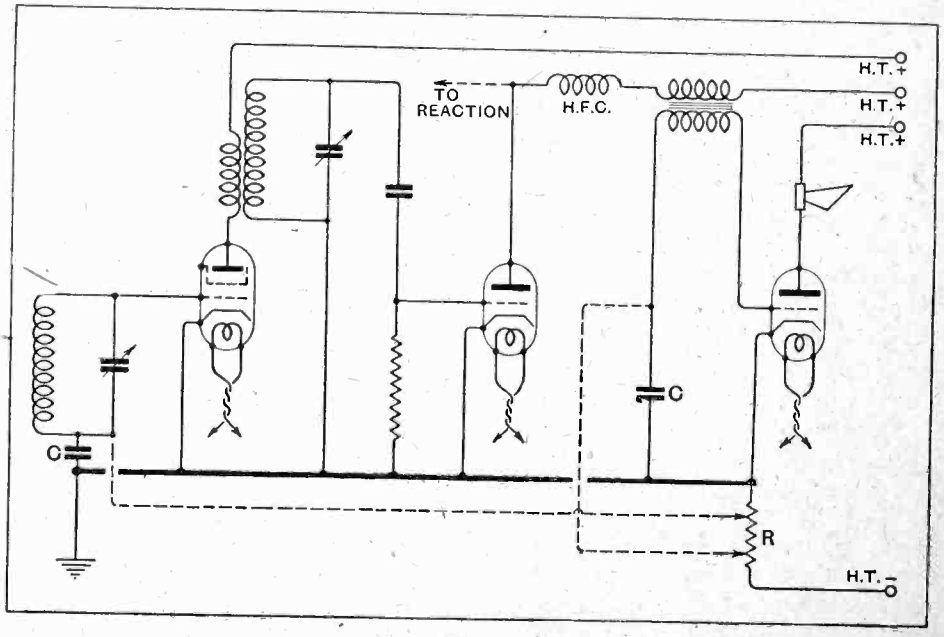

Fig. 2.—The "base line" of an A.C. mains receiver with free grid bias. Decoupling devices, etc., are omitted.

valves are connected to their respective cathodes through the bypass condensers C, which would invariably be found in a practical design.

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DEFINITIONS.

In describing the features of a receiver, and when giving information regarding its alteration or testing, reference is often made to the "low-potential end" of an anode circuit. This expression seems to puzzle some wireless amateurs: as it is a useful one, often saving a good deal of verbiage or sketching of diagrams, a word of explanation may not be out of place.

As generally understood, the expression refers to that end of the anode working load—transformer primary, choke, resistance, etc.—which is remote from the end that is connected to the anode of the valve. Any incidental components, such as decoupling or voltage-absorbing resistances, fuses, or meters that are connected between this point and the source of H.T. supply, are referred to as being at the low-potential end of the circuit. Actually, with regard to D.C. voltage, they are at higher potential than is the anode, but in this case we are dealing with high- or low-frequency signal impulses.

Similarly occasion often arises to refer to the "grid return lead." This lead may be defined as that joining the end of the "working" grid circuit component — transformer secondary, tuned coil, grid leak, etc., to the cathode or negative filament socket. Bias cells, for example, are said to be inserted "in the grid return lead."

The PENTODE and POWER OUTPUT

The Causes and Prevention of Distortion.

By E. YEOMAN ROBINSON,
(Chief Engineer, Radio Valve Dept., The Cosmos Lamp Works Ltd.).

A GREAT deal of attention has lately been given to the calculation of undistorted output available to work a loud speaker, for without a knowledge of this factor it is difficult to compare the merits of different power valves and to predict what volume of sound will be obtainable from the speaker. As a rough guide it is usual to assume that from 700 to 1,000 milliwatts are necessary when a moving-coil speaker is used in an ordinary sized living-room, while most moving armature speakers will be satisfied with 500 to 600 milliwatts. For a small hall 1,500 milliwatts upwards will be necessary. When considering the power output of a triode it is usual to define the maximum undistorted output as the maximum power output which can be obtained with the production of a 5 per cent. second harmonic component.

OWING to the peculiar characteristics of the pentode the calculation of suitable speaker impedance and the available undistorted output is not susceptible to the same treatment as that of a triode. Often the distortion due to the third harmonic is greater than that of the second; in this article the method of measuring distortion is clearly described, and it is shown how by the use of a milliammeter the presence of the second and third harmonic components may be detected and prevented

In the case of a pentode the *third* harmonic is often greater than the second, and, therefore, the maximum undistorted power output of a pentode is given for a 5 per cent. third harmonic or a 5 per cent. second harmonic, *whichever be the greater*. This is determined in the manner shown below. In practice it is found that maximum undistorted power output occurs when the second harmonic distortion is practically zero. The optimum load must be found by methods of trial and error; as a first approximation the load to give about zero second harmonic should be determined.

The new indirectly heated pentode — the Mazda AC/Pen—will be taken as an example. The optimum load line for this valve is shown at CC¹ in Fig. 1, and is for a resistance of 10,200 ohms. Since grid current does not flow at negative grid voltages the grid can swing to zero grid volts, consequently the total grid swing ranges from 0 to −20 volts, for the optimum bias is −10 volts when the screen potential is 200 volts. The dynamic characteristic for the above conditions of operation is plotted in Fig. 2. It will be seen that P_1, P_0 and P_2 lie nearly on one straight line, so that the second harmonic is very small. The second harmonic may be computed in the usual manner from expression (*a*) in the appendix.

It will be seen that the dynamic curve on the right-hand side of the mean P_0 is concave upwards, whilst the curve on the left of P_0 is concave downwards. This curvature gives rise to the production of a third harmonic component. To obtain the percentage third harmonic distortion the curvature of the characteristic from P_1 to P_0 should be measured, and that from P_0 to P_2, and a mean value determined. To simplify the measurement it is usual to take the curvature from P_0 to P_2 only, i.e., on the upper half of the dynamic curve, provided it is not appreciably greater than 5 per cent. This gives a factor of safety, because under correct operating conditions the curvature from P_1 to P_0 is always less.

Referring to Fig. 1 at $E_g=0$, $E_g=-5$, $E_g=-10$, the anode current characteristics cut the load line at 47, 39.5 and 30 milliamperes respectively. For upward curvature (Fig. 2) the distortion formula is given by expression (*b*) in the appendix, and it is there shown that the third harmonic distortion is about 5.9 per cent.

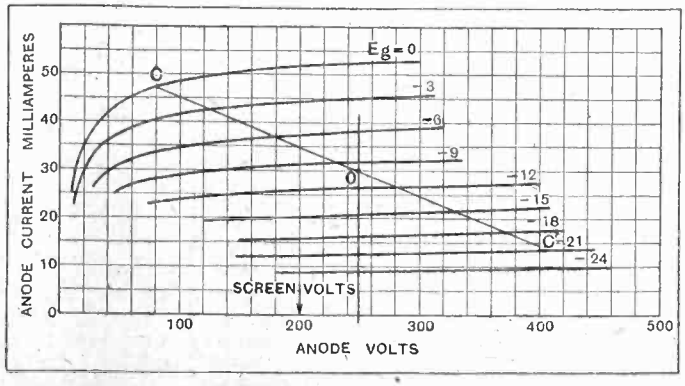


Fig. 1.—Anode volts/anode current curves of an AC/Pen valve. The line CC¹ represents a load of 10,200 ohms and O is the operating point. The maximum screen and anode volts are 200 and 250 respectively.

The power output is equal to I^2R when I is the R.M.S. value of the A.C. component of the output current. This current *fluctuates from* 14 *to* 47 *milliamperes*, i.e., the A.C. current is

$$\frac{47-14}{2}=16.5 \text{ mA. (peak)}$$

$$=\frac{16.5}{\sqrt{2}}=11.65 \text{ milliamperes R.M.S.}$$

The power output is therefore $(11.65)^2 \times 10{,}200 \times 10^{-6} = 1{,}390$, roughly, 1,400 milliwatts.

The Pentode and Power Output.—

The true secret of obtaining satisfactory results from a pentode lies in paying attention to the value of the load impedance, for should this be too low the power output will be small, whilst if it is too high serious harmonic distortion and over-voltages will be produced. It is therefore of interest to observe the power output and distortion at loads other than the optimum. Fig. 3 shows the dynamic characteristics of the A.C./Pen. valve for various values of load resistance, whilst in Table I this information is given in tabular form. Columns 3 and 4 give the percentage of second and third harmonics present respectively when a grid swing equal

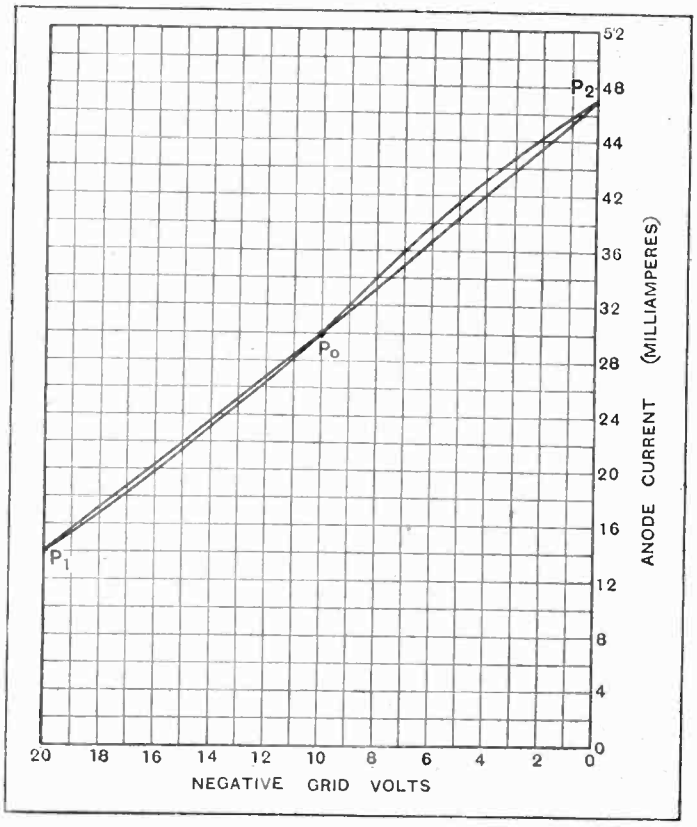


Fig. 2.—Dynamic characteristics for the conditions given in Fig. 1.

to the grid bias is applied to the valve, *i.e.*, the maximum grid swing for the optimum load impedance of 10,200 ohms.

Referring once more to Fig. 3, it will be seen that owing to the peculiar shape of the dynamic characteristic curvature distortion on high-load resistances can be avoided by reducing the grid swing. For example, with a 20,000 ohms load the dynamic curve is sensibly straight if the grid swing is restricted to 5 volts. This characteristic feature is important, for whereas the load impedance must not rise above 10,000 to 12,000 ohms under ordinary conditions of working (if the harmonic distortion is to be not more than 5 per cent.), assuming the signal strength has already been reduced at high frequencies by side band cut-off, etc., the load impedance can be permitted to rise to comparatively high values at these frequencies without distortion occurring. It is estimated that actually a harmonic distortion up to 10 per cent. can be employed in practice when a moving-iron type loud speaker is used, and therefore columns 5 and 6 have been added to Table I.

These columns give respectively the maximum power output available when the distortion is limited to 10 per cent., and the maximum grid swing which is permissible for this restriction in harmonic distortion. From this it will be noticed that whilst with a 30,000 ohms load and a 10 volt grid swing the third harmonic is 19.4 per cent., this distortion is reduced to 10 per cent. if the grid swing is restricted to 7 volts.

Advantages of the Pentode.

There are two main reasons for employing a pentode instead of a triode. One is to obtain greater sensitivity, and the other to obtain "brilliant" loud speaker reproduction by accentuating the high audio-frequency notes and thus compensating for the inferior performance of the loud speaker at high frequencies, and for side band cut-off and various capacity losses. The best load impedance to adopt will depend entirely on the impedance-frequency characteristic of the speaker, and whether the speaker, the set, or the transmission is responsible for the loss of high audio-frequency notes. To simplify consideration of the problem it is best to consider the use of the A.C./Pen. valve under three different conditions:—

Case 1.—Consider the case in which there is no appreciable high-note loss in the amplifier, and likewise there is no lack of high audio-frequency reproduction in the speaker. The A.C./Pen. valve is used to obtain greater sensitivity.

Under these conditions the movement of the speaker should be such that the impedance is substantially constant over the working frequency range; an output transformer should be used to adjust the load on the valve to 10,000 ohms. Preferably a tapped choke should be used in order to reduce the leakage reactance which, by increasing the impedance at high audio-frequencies, will cause harmonic distortion. Since the impedance of practically all loud speakers increases with frequency, a limiting resistance load should be placed across the choke as shown in Fig. 4. To prevent the resistance reducing the power delivered to the speaker except at high audio-frequencies a condenser should be connected in series as illustrated. The best value of the resistance

TABLE I.

OUTPUT CHARACTERISTICS OF MAZDA A.C./PEN VALVE.

1 Load (ohms).	2 Undistorted power output (Milliwatts).	3 Second harmonic Distortion (Per cent.).	4 Third harmonic Distortion (Per cent.).	5* Max. output for 10% distortion. (Milliwatts).	6 Max. grid swing for Column 5 (volts).
2,000	370	7.1	3.0	370	10
4,000	670	6.2	2.8	670	10
6,000	970	5.5	2.7	970	10
8,000	1,160	4.4	2.5	1,160	10
10,000	1,400	1.5	5.3	1,400	10
12,000	1,400	0.8	5.8	1,400	10
14,000	1,420	0.9	7.9	1,420	10
16,000	1,520	2.7	8.4	1,520	10
18,000	1,560	4.3	10.3	1,560	10
20,000	1,570	6.0	11.6	1,200	8.5
30,000	1,580	15.8	19.4	1,000	7.0

* With input limited to 10 volts swing.

The Pentode and Power Output.—

will depend entirely on individual conditions. A resistance of 15,000-25,000 ohms and a series condenser of 0.003-0.01 are suitable according to conditions. When an output transformer is employed the resistance and series condenser should be across the primary of the transformer to eliminate, as far as possible, the effects of leakage reactance of the transformer.

Case 2.—The pentode is used to compensate for poor high audio-frequency reproduction from the speaker.

In this case the characteristic of the pentode that an increased load gives increased power output is utilised. The speaker movement should have an impedance rising with frequency. To avoid harmonic distortion the transformer ratio should be chosen so that the load impedance is 10,000 ohms at the *highest frequency* at which it is desired to boost the high notes. For example, consider a speaker having an impedance characteristic as given in the table below:—

TABLE II.

Frequency	250	500	1,000	1,500	2,000	3,000	4,000	6,000
Impedance	5,500	8,000	10,000	12,000	13,000	16,000	18,000	22,000

With a 1/1 transformer the high notes up to 1,000-1,500 cycles will be boosted. To prevent distortion at

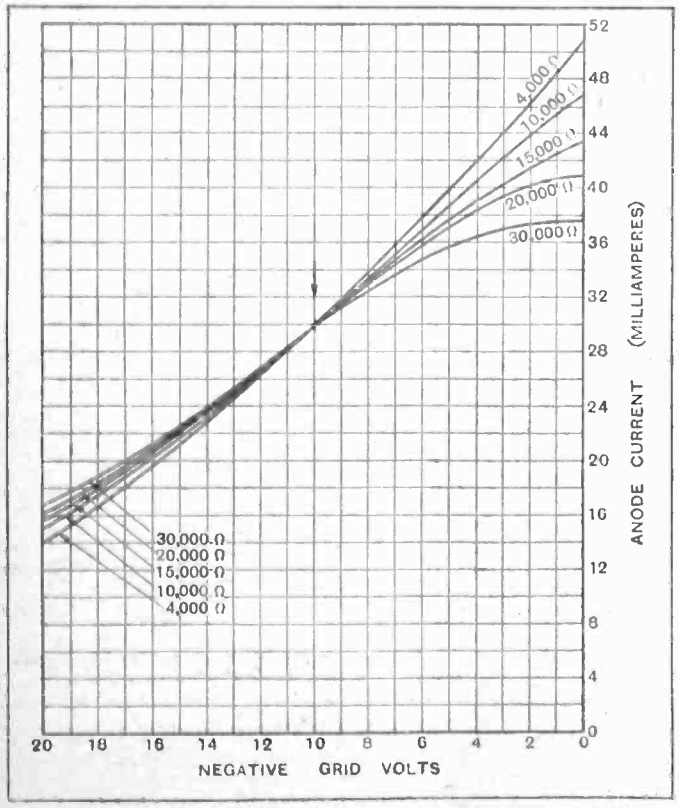


Fig. 3.—Dynamic curves of AC/Pen for various load resistances.

frequencies higher than 1,500 cycles, a by-pass resistance and a series condenser must be used. Suppose, however, it is desired to boost the frequencies up to 3,000 cycles. For the purpose a 1/1.25 transformer would be required, and the series condenser should be decreased in capacity to bring the by-pass resistance into operation at a higher frequency.

Case 3.—The pentode is used to compensate for high audio-frequency loss in the amplifier due to sideband cut-off, poor transformers, or an inferior gramophone pick-up.

In this case, if the high audio-frequency signal has been relatively reduced in amplitude, the load impedance can be permitted to rise to even 30,000 ohms without distortion. A by-pass resistance is hardly necessary, but if used it should have a value of 30,000 to 40,000 ohms.

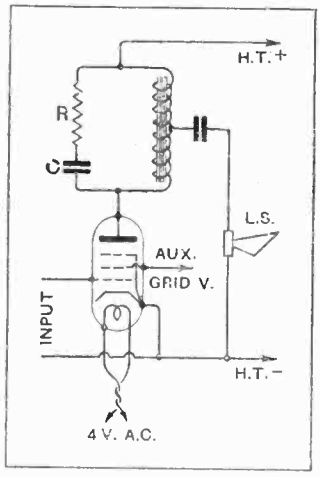


Fig. 4.—A suitable output circuit for a pentode. The filter CR prevents accentuation of the higher audio frequencies with certain loud speakers.

The impedance and response characteristics of various loud speakers are so widely different that it is impossible to give any generalised formulæ for employing a pentode. The easiest way to analyse what is occurring is to place a milliammeter in the anode circuit of the valve. If when a strong signal is applied, the milliammeter needle flicks upwards, second harmonic distortion is occurring, and a greater load impedance will reduce this second harmonic distortion and give increased power output. If, on the other hand, the needle dips downwards, third harmonic distortion is produced, and the load impedance must be correspondingly reduced. If the third harmonic distortion is only occurring at high frequencies, it can be prevented by varying the values of the by-pass resistance and series condenser. It should be remembered that the optimum output impedance is dependent upon the anode voltages and screen voltages employed. For example, with a screen voltage of 200 the optimum impedance for an anode voltage of 250 is 10,200 ohms. With an anode voltage of 200 the optimum load impedance is only 8,000 ohms. This voltage is the actual anode voltage on the valve, and it will be found with many pentode chokes and output transformers as much as 40 or 50 volts may be dropped in the choke, so that, to obtain a voltage of 250 at the anode, a supply voltage of 290 to 300 volts may be necessary.

Greater Stability with the A.C. Valve.

The fact that the A.C./Pen. valve is fitted with an indirectly heated cathode may be utilised to advantage when the valve is employed in a set equipped with one or two screened high-frequency stages. In such sets one cause of possible instability is back coupling through the heater wiring. This is prevented by connecting the heater wiring to the cathode. If an ordinary filamented pentode is employed, the cathodes of the early-stage valves are connected to the centre tap of the fila-

The Pentode and Power Output.—

ment transformer secondary, or to the centre tap of the potentiometer connected across it. Inasmuch as there must be some impedance between the heater wiring and the cathode, feed-back may be introduced. This can be completely avoided when an indirectly heated output valve is used by connecting all the cathodes in parallel to one end of the heater transformer secondary winding.

After reading this article the reader may feel that the problem of using a pentode is hedged around with many difficulties, for the working impedances of loud speakers are not widely known. It was stated[1] recently in *The Wireless World* that "... properly used it is believed that the pentode will give as satisfactory reproduction as a triode, and it is quite certain that no valve will give as many milliwatts output per volt input." It is hoped that the information given will enable the conditions for satisfactory use to be realised. After all, the only real difficulty of making a pentode give the same quality of reproduction as a triode is to keep the load at all frequencies as far as possible the same, and keep it close to the optimum value. This optimum is, in the case of pentodes, much more sharply defined than in the case of triodes. Whereas the average listener may be unable to determine aurally the difference in performance of a triode working a moving-coil speaker with transformer ratios of 10/1 and 30/1, with a pentode a difference can be determined between such comparatively close ratios as 20/1 and 25/1. The high power output and phenomenal sensitivity of the A.C./Pen. valve are so marked that the extra attention to the load which is necessary to obtain pure reproduction is well worth while.

[1] See "The Power Pentode Two," May 7th, 1930, p. 477.

APPENDIX.

For the calculation of second harmonic the following expression is used:

$$\frac{\frac{1}{2}(\text{I. max.} + \text{I. min.}) - \text{I}_0}{\text{I. max.} - \text{I. min.}} \times 100\% \quad \ldots \quad (a)$$

In the case under discussion this becomes

$$\frac{\frac{1}{2}(47 + 14) - 30}{47 - 14} \times 100 = 1.5\%$$

The expression for third harmonic distortion is

$$\frac{\text{I}_0 - \frac{1}{2}(\text{I. max.} + \text{I. min.})}{\text{I. max.} - \text{I. min.}} \quad \ldots \quad (b)$$

Taking the case mentioned in the text we have

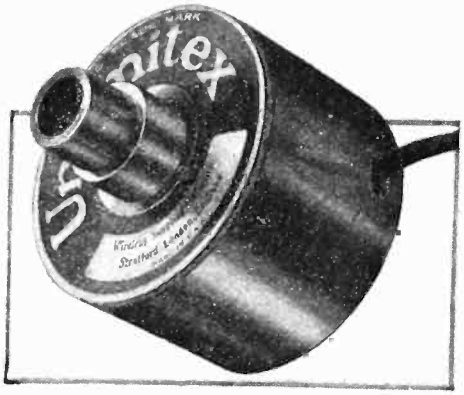
$$\frac{39.5 - \frac{1}{2}(47 + 30)}{17} \times 100 = \frac{39.5 - 38.5}{17} \times 100 = 5.9\% \text{ approx.}$$

LABORATORY TESTS on New Apparatus.

A Review of Manufacturers' Recent Products.

UNLIMITEX LOUD SPEAKER MOVEMENT.

In these days of cone diaphragms and moving coils it is interesting to find an example of a unit designed for use in conjunction with a horn. The Unlimitex unit is undoubtedly a distinct advance over the old-fashioned soft iron diaphragm movement at one time associated with horn loud speakers. The diaphragm is spun from thin aluminium sheet with a conical depression in the centre surrounded by concentric corrugations to give the requisite degree of flexibility. The edge is clamped between rubber rings which effectively damp out any metallic quality in the reproduction. A balanced armature movement of substantial dimensions is coupled to the apex of the diaphragm through a short, thin rod, and the air gap is sufficiently wide to prevent chattering.



Unlimitex balanced armature unit for horn loud speakers.

The unit was tested in conjunction with a folded exponential horn having a cross section of four square feet at the flare. Using a super-power output valve capable of delivering 1,000 milliwatts, no trace of chattering could be provoked, but it was noted that the sensitivity was somewhat lower than that of the average cone loud speaker, possibly due to the size of the air gap. The bulk of the acoustic output lay between 300 and 1,750 cycles with detectable resonances at 400 and 1,500 cycles. The unit definitely responds to frequencies as high as 6,000 and as low as 50, but the output outside the limits from 300 to 1,750 is comparatively small. The impedance rises from 1,820 ohms at 50 cycles to 28,600 ohms at 6,000 cycles with an average value at 800 cycles of approximately 10,000 ohms.

The price is 18s. 9d., and the makers are Wireless Supplies, Unlimited, 278, High Street, Stratford, London, E.15.

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FRANKLIN FIXED CONDENSERS.

A new range of condensers available in capacities up to 0.0005 mfd. with mica dielectric, and up to 10 mfds. with paper dielectric, is now available from the Franklin Electric Company, 187-189, Ilford Lane, Ilford, Essex. These condensers are housed in metal containers and are provided with either screw terminals or soldering tags. In view of the arbitrary ratings now applied to large capacity condensers, a six months' guarantee is given that Franklin condensers will not break down if the rated working conditions are not exceeded. For the purposes of test a 1 mfd. condenser rated as suitable for 160 volts A.C. or 240 volts D.C. and labelled as withstanding a test voltage of 500 D.C. was left in circuit on a steady 1,000 volts supply. It withstood this test without breakdown as well as the severe conditions imposed by repeatedly discharging by short circuit.

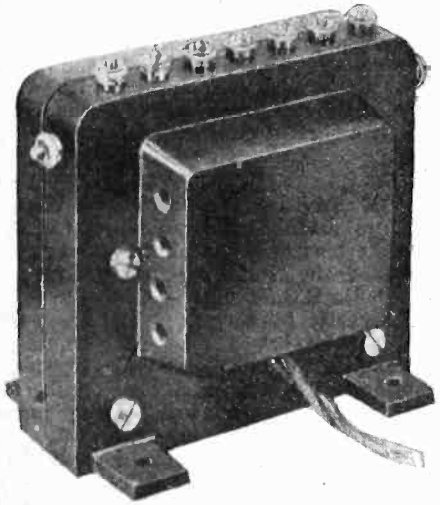
Two examples of the Franklin fixed condenser reviewed on this page.

The prices are, 1 mfd. size 2s., 500-volt D.C. test class, 2s. 6d. for the 500-volt A.C. test class, and 2s. 6d. for the 1,000-volt D.C. test class. Other types are available carrying ratings up to 5,000 volts D.C. test, and the condensers are moreover available in block form for use in eliminators.

"ELECTROFICIENT" MAINS TRANSFORMER 4 IDH AND L.F. CHOKE.

Made by Messrs. Graham Farish, Ltd., Masons Hill, Bromley, Kent, these two components form the basis of a battery eliminator for A.C. mains. The type 4 IDH transformer has been designed for 210-volt 50-cycle supplies, and is intended for use with a valve rectifier of the 4-volt class. Full-wave rectification is allowed, the H.T. secondary winding being centre-tapped. In addition, there is a 4-volt coil rated to deliver up to 5 amps of current for the indirectly heated type of A.C. valves.

Some measurements were made of the A.C. output from the various windings on load. Each half of the H.T. secondary coil was tested separately, but as their outputs were sensibly the same, the readings obtained from one half only will be given here. The input voltage was maintained at 210 volts throughout these tests. With a load of 5 mA. the A.C. voltage was 241, at 20 mA. 237.5, and at 40 mA. 231 volts. These are R.M.S. values. It will be seen that the regulation is very good.



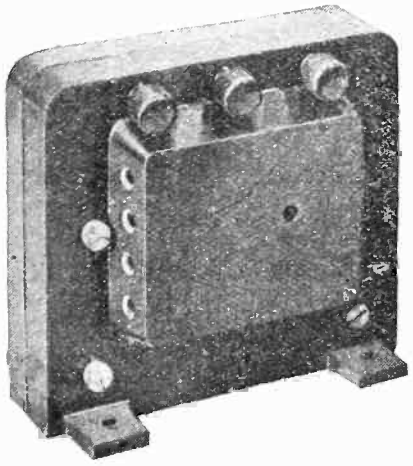
"Electroficient" mains transformer, type 4 IDH.

The voltage given by the 4-volt 5-amp. coil was as folows :—

R.M.S. current. in Amps.	R.M.S. volts.
1	4.3
2	4.13
3	4
4	3.85
5	3.67

The rectifier filament coil gave 4.1 amps on a load of 1 amp., and 3.9 volts at 2 amps. The price of this transformer, which is enclosed in a bakelite case, is 39s. 6d.

The choke, which is a complementary component, being housed in a similar case, and price at 22s. 6d., has a nominal inductance of 30 henrys, and rated to carry 50 mA. It is provided with a centre tap. Its measured inductance at 50 cycles was found to be 56.5 henrys without D.C. flowing, 54.25 henrys with 10 mA., 50.2 henrys with 20 mA., 45.25 henrys with 30 mA., 40 henrys with 40 mA., and 34.8 henrys with 50 mA. of D.C.



"Electroficient" H.T. smoothing choke.

During test the A.C. volts across the choke were maintained at 50, and the R.M.S. current increased progressively from 2.6 mA. to 4.3 mA. as the impedance fell. With the maximum permissible value of D.C. flowing the inductance is sufficiently high to assure adequate smoothing of the rectified voltage when used in conjunction with about 8 mfd. of capacity.

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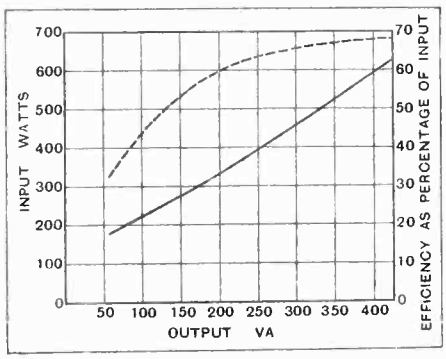
BAYLISS ROTARY CONVERTER.

The function of this machine is to provide an A.C. supply from the direct current mains, thereby enabling power amplifiers, radio-gramophones, and similar apparatus designed for A.C. operation to be used in these cases. At one end of the armature is fitted a 38-section commutator and at the other end two slip rings, while on an extension of the spindle is carried a small fan. This maintains a constant current of air through the armature tunnel and prevents undue heating of the coils. On test there was no appreciable temperature rise even after a lengthy run on full load.

The leads from the commutator brushes are brought out to a 4-way terminal block mounted slightly to one side of the centre on the top of the field casing and protected by a circular cover. The two other contact sockets on this block are the ends of the field winding. Another terminal block, similarly covered and mounted on the top of the casing, gives connection to the A.C. winding. Under normal conditions a small machine of this type would be series connected—our tests were carried out with this particular arrangement—so that one end of the field should be connected to one of the brush leads. A starter, connected in the usual way, can then be employed.

The A.C. output is nominally 150 volts at 50 cycles, but by utilising the special auto-transformers made by the same firm for use with the machine, any voltage up to 250 can be obtained. The overall efficiency is not materially affected by employing this component, as it is designed on generous lines. Curves showing the relationship to input watts and output volt/amps., also the efficiency as a percentage of the input watts, have been prepared and are reproduced here.

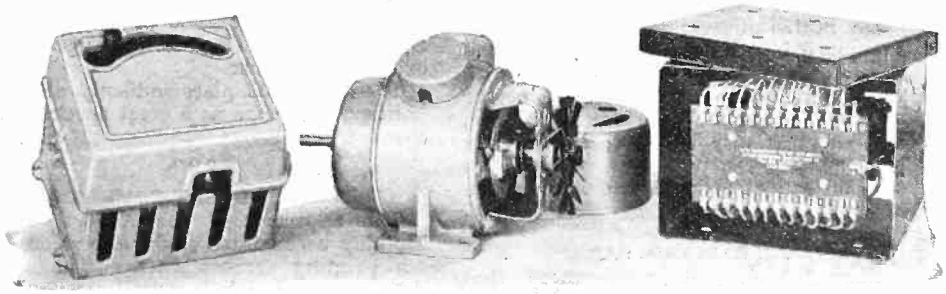


Efficiency curves of the Bayliss 400-watt rotary converter.

The maximum efficiency is of the order of 68 per cent., this being attained at an output of 400 V.A. These measurements do not take into consideration the transformer, and with this included, the overall efficiency was lowered by about 3 per cent.

The A.C. output is modulated slightly by D.C. ripple, and in most cases it will be necessary to incorporate smoothing equipment in both the input and the output leads. The anti-interference units specially made by the Dubilier Condenser Co. (1925), Ltd., for machines of this type were found an efficient remedy for this particular trouble.

The price of the machine, which is rated at 400 watts, is £12 10s.



Bayliss D.C. to A.C. rotary converter with end cover removed, showing the cooling fan, Also the auto-transformer.

CURRENT TOPICS

News of the Week in Brief Review.

SHOUTING EACH OTHER DOWN.

The "Battle of the Giants" which was forecast in our editorial articles in October and November of last year, bids fair to develop into a stentorian bawling match between the high-power station in Moscow and those in neighbouring countries who do not altogether appreciate the propaganda transmitted by Soviet Russia. Germany has formally protested against the messages broadcast on May Day from Moscow to the "Policemen and Soldiers of Germany," Rumania has a counter station which shouts down Moscow whenever it starts talking in Rumanian, and on the other side it is stated that a station is to be erected in the Volga Republic to drown the religious broadcasts from Berlin with the "Godless hour" from Moscow and prevent German settlers receiving Christian comfort from their fatherland.

Cynical prophets declare that when international disarmament is accomplished war will still be waged in the form of slanging matches through the medium of higher and higher-powered stations.

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THE BRITISH ATTITUDE.

We are perhaps fortunate in the fact that the B.B.C. policy tends rather in the opposite direction, as their unwillingness to allow anything in the nature of controversial propaganda led to a refusal to broadcast any of the proceedings of the Albert Hall meeting to protest against religious persecution in Russia.

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THE REIGN OF NOISE.

We often find curious contradictions in individual countries. At one end of the scale the penalties for using noisy loud speakers to the annoyance of one's neighbours are becoming more rigorous—Leipzig and Hanover, if we remember aright, are conspicuous in framing drastic regulations for the abatement of this nuisance—but at the other end of the scale of noise we hear of a new giant loud speaker in Germany which can be carried in a balloon and used to bawl information to a whole city.

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FRENCH "PHANTOM" STATIONS.

The broadcasting question still arouses much heated discussion in France, and one journal, referring to the new Lille-Camplin Station, the foundations of which were recently dug, describes it as another of the "phantom" stations of France, and enquires why "two or three really good stations are not made available at once instead of a dozen mediocre or non-existent ones."

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TELEARCHIC CARS.

From Barcelona it is announced that on July 4th successful trials were made of a motor car, steered by wireless from another car, which made a tour of the principal streets of the city. Our Paris correspondent sardonically remarks that this practice might well be introduced there as well as in some other French towns where to the spectator who is active enough to escape destruction the automobiles appear to be entirely without guidance.

BEWARE OF ROBBERS!

Information has recently reached us of two attempts to obtain unauthorised possession of Marconiphone apparatus. In each case the attempt took the form of a visit to the house of a customer by a man who said he had been sent to collect the apparatus. Fortunately, in both instances the customers refused to accede to this request.

All authorised Marconiphone officials and employees, we are informed, carry an identification card which they produce when calling on customers to deal with or receive apparatus, in addition to which their call is always advised by correspondence. In the absence of these safeguards our readers should refuse any requests from callers purporting to take possession of or deal with apparatus.

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OBITUARY.

We regret to record the death on Monday, July 14th, of Mr. J. P. Clark, one of the Senior Engineers of the Marconi Company.

Mr. Clark entered electrical engineering as a student at Faraday House, where he passed out as a Prizeman. He was then engaged for some years in electrical engineering in Yorkshire before he joined the Marconi Company in 1913.

For a number of years past Mr. Clark had been Chief of one of the Contract Sections in the Engineering Department of Marconi House.

His death took place suddenly while on holiday, and came as a great shock to his many friends.

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SMALL ADVERTISEMENTS.

The approach of the August Bank Holiday necessitates slight alterations in our printing arrangements. The latest date on which small advertisements can be accepted for *The Wireless World* of August 6th is Wednesday, July 30th.

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"WIRELESS WORLD" INDEX AND BINDING CASES.

The index for Volume XXVI, January to June, 1930, is now ready, and may be obtained from the publishers, price 4d., post free, or together with binding case 3s. 1d. post free.

WIRELESS SETS FOR INVALIDS.

A fund to provide wireless crystal sets for poor invalids has been started in Newcastle by the Citizens' Service Society.

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THE TELEVISED PLAY.

The first attempt to broadcast a play by the Baird system of Television has aroused considerable interest and not a little criticism in the daily Press. It seems generally agreed that the recent representation of "The Man with a Flower in His Mouth" was most interesting from a scientific point of view, but that the dramatic limitations are at present very restricted as only a portion of each actor can be shown on the screen at one time, and short interludes are necessary to enable each performer to take his place before the projector when his turn comes.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION.

At the opening meeting of the International Electrotechnical Commission in Copenhagen the delegates were welcomed by Mr. Bulow on behalf of the Municipality, Mr. P. Munch, the Minister of Foreign Affairs, and Prof. Pederson, President of the Danish Electrotechnical Committee, who was able to show them the actual magnetic needles with which Oersted first observed the influence of an electric current on a magnet.

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NOMENCLATURE.

The Advisory Committee on Nomenclature made considerable progress with the International Vocabulary and recommended the following new names for magnetic C.G.S. units :—

Magnetic Flux	Maxwell
Flux Density	Gauss
Magnetic Flux Intensity ...	Oersted
Magneto-Motive Force ...	Gilbert

the term "Pro-maxwell" being agreed as the name for the practical unit.

Advisory Committee No. 3 on Symbols has already prepared Publication No. 27 containing electrical and mathematical symbols, rules, and abbreviations for metrical weights and measures, and has in hand the preparation of the second edition of Publication No. 35, which, beside the graphical symbols used for heavy-current installation, will include those for telephone, telegraph and radio-electricity.

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NEW BROADCASTING STATION FOR AUSTRALIA.

Plans are being prepared for the erection of subsidiary broadcasting stations at Rockhampton, Newcastle and Brooklyn Park in Australia.

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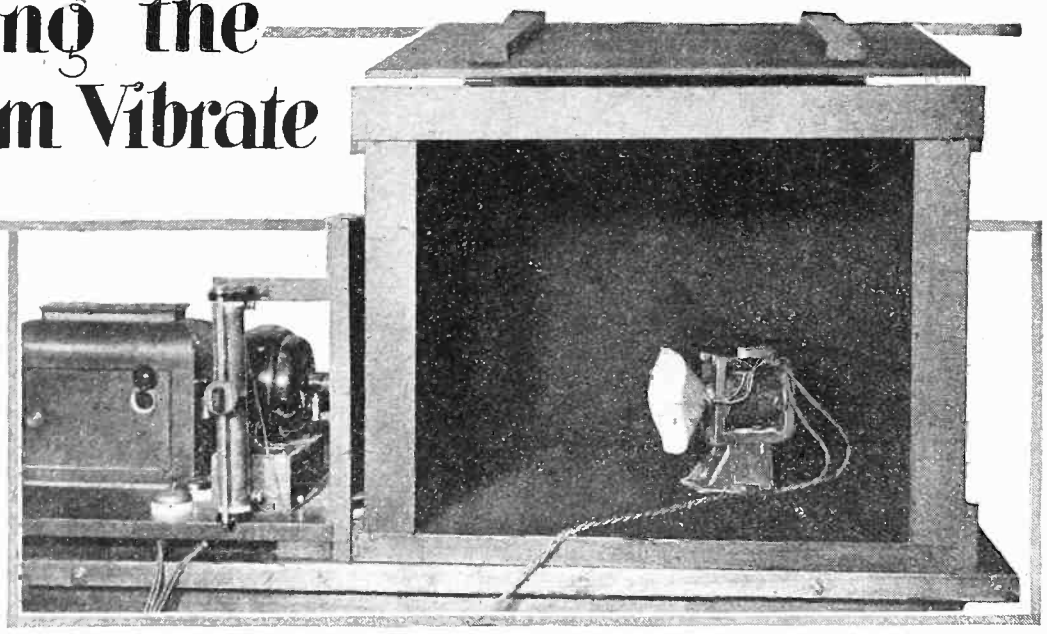
VALVE HISTORY IN 15 SECONDS.

The world's largest electric sign will shortly tell the complete story of the RCA Radiotron wireless valves in approximately 15 seconds, according to a publicity note from the company's offices at Harrison, New Jersey, where the sign is to be erected. Employing 4,000 Mazda lamps with a load of 134,975 watts, the sign will display the jumping notes of the theme song "Hail to the Chief" to 140 million people who pass the spot each year.

Watching the Diaphragm Vibrate



By
G. F. DUTTON,
Ph.D., D.I.C.
(The Gramophone Company Ltd.).

A Demonstration of this Apparatus was given before the Royal Society at their Conversazione on June 25th.

Stroboscopic Examination of Modes of Vibration.

IT is well known that all types of diaphragm possess natural modes of vibration. These are present whatever the shape or pattern of the diaphragm, but the mode of vibration is dependent upon such physical properties of the diaphragm as stiffness, mass, and shape. Readers will be familiar with the vibration patterns which can be shown by means of dust and sand figures and are particularly easy to obtain in the case of flat telephone diaphragms, but this method has its limitations, for, although it is, of course, of extreme interest in the study of the subject, it only serves to show up the nodal lines along which the vibration is a minimum at any particular frequency.

The arrangement for examining loud speaker diaphragms which it is proposed to describe is of rather special interest, because it permits the measurement of the relative amplitudes and phases of the diaphragm.

It is well known that movements can be observed at "slow motion" when illuminated by intermittent light on the stroboscope principle. To observe the vibrations of the diaphragm of, say, a moving-coil speaker, the diaphragm is viewed either through a stroboscopic shutter, or alternatively the diaphragm is illuminated by a beam of light passing through a stroboscopic shutter. The vibrations of the diaphragm can then be seen at "slow motion." The method is most effective at low frequencies, but useful observations can still be made up to frequencies of the order of 1,000 cycles per second. At higher frequencies the amplitudes become too small, and the vibrations have to be observed with the aid of small pivoted exploring mirrors by the arrangement used by Dr. Kennelly.

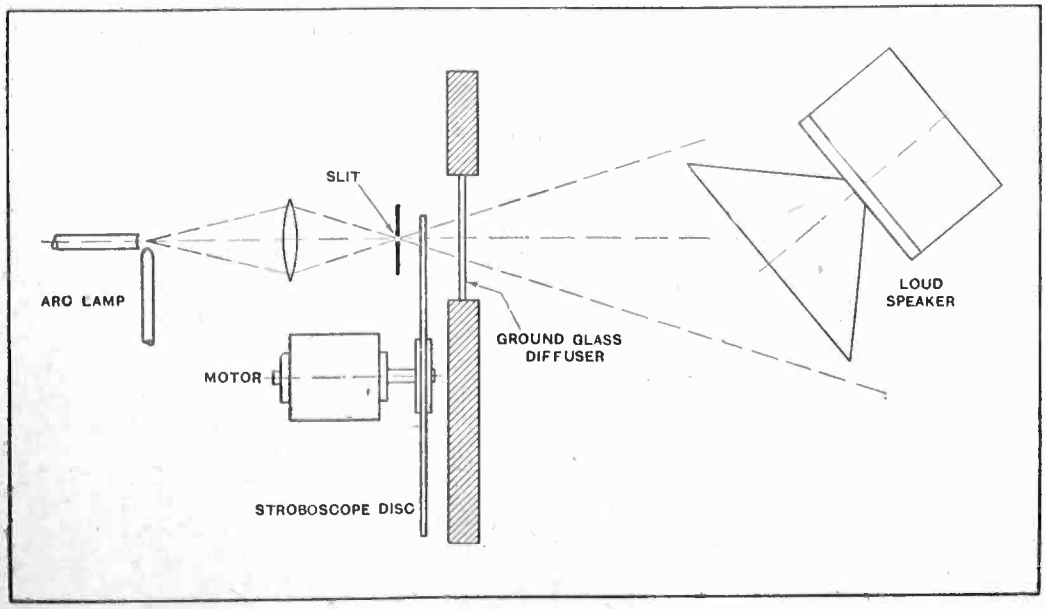


Fig. 1.—Diagram showing method of setting up the apparatus for observing diaphragm vibrations.

The apparatus which was used in the tests described and shown in the title photograph and in Fig. 1 consisted of an ordinary arc lamp employed to project a concentrated beam of light through a slotted disc. This disc was fitted to the spindle of an electric

Watching the Diaphragm Vibrate.—

motor the speed of which could be controlled within fine limits. The rotating slotted disc served to interrupt the light. It was found convenient to place the speaker which it was intended to examine in a large box about 4ft. square and lined with thick black felt. The purpose of this was in order to have a dead-black background against which the illuminated diaphragm would show up well, and, secondly, the box provided an effective means of absorbing a proportion of the sound emitted from the speaker which became rather annoying to observers when large amplitudes were used.

An Interesting Field for Experiment.

Some interesting experiments have been carried out employing cones of about 7in. in diameter and supported only at the centre to a "moving coil." It can be seen that in this "free edge" condition the diaphragm vibrates as a rigid piston only at low frequencies up to about 50 cycles per second, and on reaching 60 cycles per second the diaphragm vibrates with two nodal diameters as illustrated (Fig. 2). If now we continue to increase the frequency it will be observed that the two nodal diameters become less marked, and if we continue to increase the frequency up to about 100 cycles per second three nodal diameters appear and become definite at about 130 cycles per second. The number of diameters continues to increase with increase in frequency of vibration, and as many as twelve nodal diameters have been observed with this arrangement.

The alternate segments of the nodal figures vibrate in opposite phase, so that there is considerable loss in radiation efficiency taking place under conditions where the dimensions of the segments are small when compared with the wavelength of the sound emitted. This phenomenon is especially striking to the observer when the diaphragm is vibrating at 60 cycles per second and the free edge cone takes the form of two nodal diameters. The maximum amplitude at the edge of the cone may be as much as half an inch, yet the sound radiation may be scarcely perceptible. The segmental vibration may be suppressed by loading the diaphragm edge with flexible material, such as velvet. If, say, a ring of velvet half an inch wide is glued to the diaphragm edge and clamped at its outer edge to a rigid support, it will then be seen that with this loading of the diaphragm edge it is possible for the cone to vibrate approximately as a rigid piston up to 200 cycles per second. This naturally has the result of increasing the radiation efficiency many times, because the segmental vibration is now suppressed.

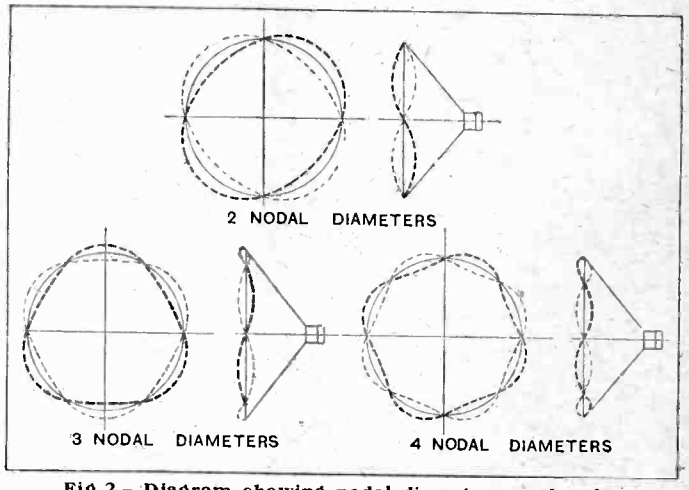


Fig.2.—Diagram showing nodal diameters produced at various frequencies.

This little experiment is extremely instructive, and it is well worth the while of the amateur and experimenter if he is interested in the study of the action of loud speaker diaphragms to fit up the necessary apparatus to repeat the experiments. Various materials can be employed for the diaphragms, and the effects of different methods of support can be studied. Standard frequency records might be employed if a standard frequency generator is not available to excite the moving coil.

CATALOGUES RECEIVED.

Profusely illustrated, and containing between its covers everything that has any connection, however remote, with wireless and electrical reproduction, is a very brief summary of the 276-page 1930 Wireless and Electrical List issued by Messrs. J. J. Eastick and Sons, Felex House, 118, Bunhill Row, London, E.C. The first few pages are devoted to valves; then follow 45 pages of illustrations and abridged descriptions of proprietary sets and cabinets, to be followed by a section dealing with eliminators and mains equipment. The following 18 pages contain illustrations and prices of practically every type of loud speaker on the market, then some space is devoted to coils, H.F. and L.F. coupling devices, condensers, fixed and variable, while the last 100 pages deal with meters, switches, and a plethora of sundries too numerous for detailed mention here.

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Abbey Radio, 47, Victoria Street, Westminster, London, S.W.1.—Price list and abridged description of "Vatea" radio valves.

The Regent Radio Supply Company, 21, Bartlett's Buildings, Holborn Circus, London, E.C.4.—Illustrated booklet describing the "Regentone" range of D.C. and A.C. battery eliminators designed especially for use in portable sets.

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Tannoy Products (formerly the Tulsemere Manufacturing Co.), 1-7, Dalton Street, West Norwood, London, S.E.27. —Descriptive folder dealing with a new "Tannoy" H.T. eliminator, model P.2. for A.C. mains, for use in portable and transportable sets.

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Baker's Selhurst Radio, 89, Selhurst Road, South Norwood, London, S.E.25.—36-page handbook illustrating and describing the range of moving-coil loud speakers made by this firm. Many useful hints are included on the use and operation of these loud speakers.

Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.—Descriptive folder dealing with the Igranic "Response Corrector," which has been designed to correct for slight deficiencies in the bass and of the higher frequencies, in gramophone reproduction, by electrical methods.

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Pertrix, Ltd., Britannia House, 233, Shaftesbury Avenue, London, W.C.2.—20-page booklet dealing with Pertrix H.T. and L.T. accumulators.

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Philips Lamps, Ltd., Philips House, 145, Charing Cross Road, London, W.C.2. —Illustrated booklet describing the Philips gas-filled thermionic rectifying valves.

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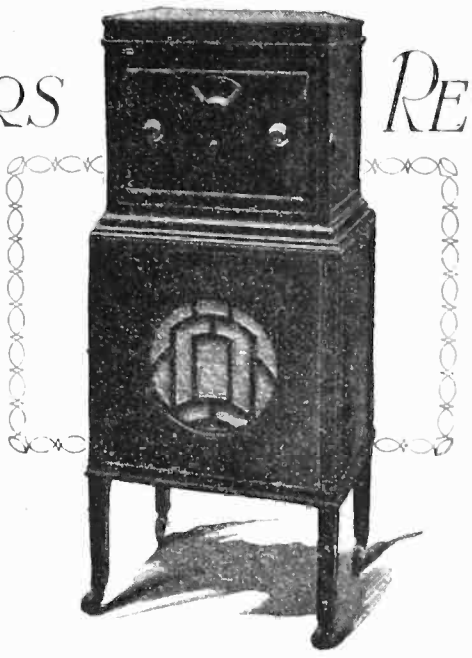
The Gramophone Co., Ltd., 363, Oxford Street, London, W.1.—Service Manual No. 1: a series of loose-leaf folders describing the fitting and maintenance of the H.M.V. radio gramophone, Model 520. Especially prepared for dealers' service mechanics.

BROADCAST RECEIVERS REVIEWED



R.I. "Madrigal" MAINS FOUR

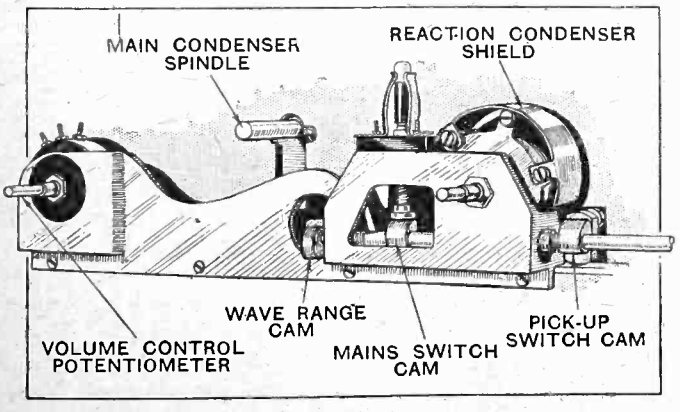
A Self-contained Transportable for A.C. Mains, Incorporating a Moving-coil Loud Speaker.

Two H.F. Stages with Indirectly Heated S.G. Valves.

IN external appearance this new production of Radio Instruments, Ltd., is similar to the "All Electric S.G. Three," reviewed in the issue of this journal dated August 21st, 1929. The circuit, however, has been completely revised and the range extended by the inclusion of *two* stages of H.F. amplification with indirectly-heated screen grid valves. With two H.F. stages there is an additional tuned circuit, and this has resulted in improved selectivity.

The tuning inductances are of the binocular astatic type to assist the efficient screening system in preventing coupling between the H.F. circuits. With high-efficiency screen-grid valves careful design is necessary if stability is to be assured, and every possible precaution must be taken to remove the last traces of inter-stage coupling.

The three main tuning condensers are ganged and occupy a sub-divided screening compartment running from back to front of the set. The circuits are balanced by trimming condensers, which are adjusted at the works, but an additional trimming condenser is connected across the first tuned circuit for the purpose of compensating for the change of capacity when an external aerial is connected. This condenser is operated by an ebonite extension rod, projecting through the screening plate under the lid of the cabinet. The aerial is coupled through a small fixed condenser.



Centralised switch gear operated by cams on a common spindle.

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The H.F. couplings consist of tuned-grid circuits with choke feeds from the H.F. valve anodes, and the change over from long to short waves is effected by short-circuiting a section of each tuning inductance.

A variable potentiometer supplies the screen-grid potential to the H.F. valves, and thus serves as a radio volume control. By a well-thought-out switching system the same resistance is used as a volume control for the gramophone pick-up, for which terminals are provided on the back of the set.

The Detector Stage.

The detector valve (AC/HL) is arranged as a leaky grid rectifier, a small positive bias being derived from the bottom end of the screen-grid potentiometer. When switched over for gramophone reproduction the necessary negative bias is provided by a resistance in series with the cathode. A similar arrangement is used for providing grid bias in the case of the two H.F. valves and the power output valve. In order to prevent damping due to grid current the detector valve is tapped across approximately one half of the tuned circuit immediately preceding. The method of tapping takes the form of a capacity potentiometer with one condenser fixed and the other variable, so that adjustment of the tapping point to the optimum value is possible. Further, this method simplifies switching, as the tapping point remains the same for both long and short waves.

The detector stage also incorporates reaction, which is capacity controlled. The detuning effect of variable reaction has been eliminated by connecting a swamping capacity across part of the reaction coil.

A single stage of L.F. amplification follows the detector, the valve being an AC/P. It is coupled to the detector by an R.I. "Hypermu" transformer, and a resistance is inserted between the grid and the secondary winding to suppress any H.F. currents remaining

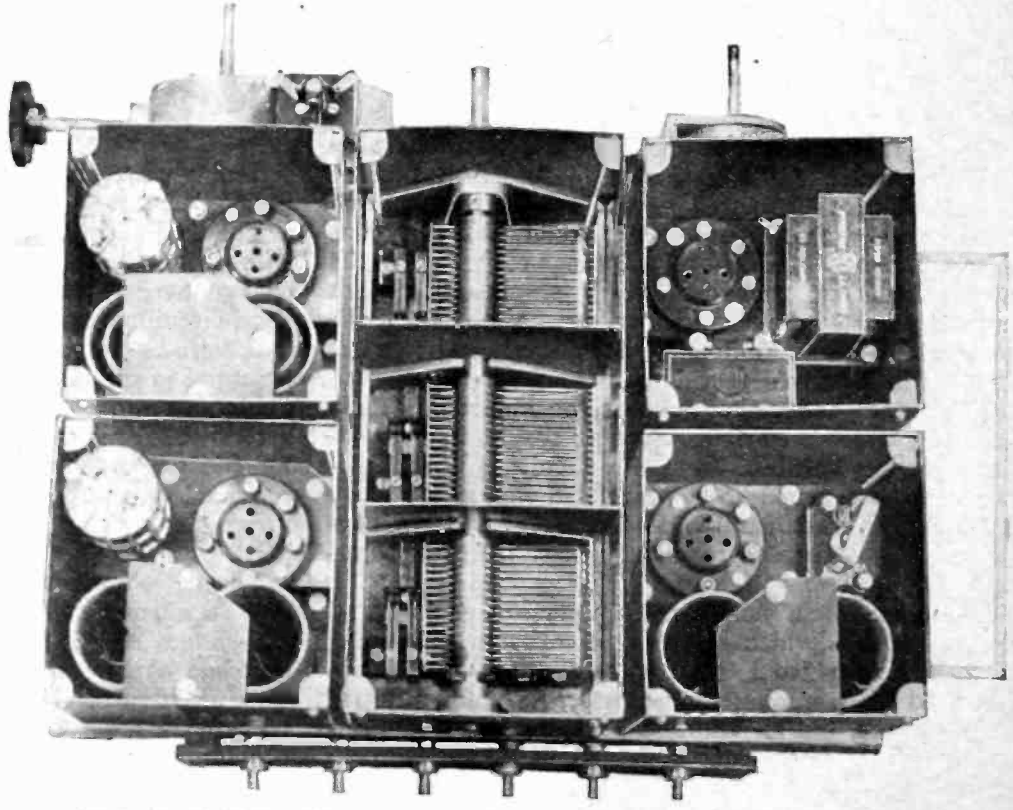
R.I. "Madrigal" Mains Four.—

after the detector stage. The output to the loud speaker is made through a choke-capacity coupling, the choke employed being the new "Hypercore," rated at 50 milliamps.

An aluminium casting at the front of the chassis houses an ingenious cam switch by means of which all the subsidiary controls are operated by a single knob let into the right-hand side of the cabinet. One cam operates the wave-range switches running through the condenser compartments, another switches in the pick-up terminals and changes over the volume control, while a third works the on-off switch in the primary of the mains transformer.

The top of the screening boxes is covered by a copper lid through which the tops of the valves project. Above this is an earthed aluminium plate which prevents stray capacity coupling between the anodes of the screen-grid valves.

Actually the earth connection is made to the centre point of the mains transformer primary through a centre-tapped condenser, and the grid of the first H.F. valve is also at earth potential as far as radio-frequencies are concerned. The valve cathodes, the whole of the screening system, the loud speaker leads, etc., therefore act as a minute aerial. The arrangement is unconventional, but appears to work satisfactorily in practice, as the H.F. amplification is adequate to deal with the minute pick-up available. The fact that hand capacity effects are negligible may be taken as evidence that the H.F. potential of the screens above earth is small and the pick-up correspondingly minute.



Plan view of the screening compartments; first H.F., bottom right; second H.F., bottom left; detector, top left; output stage, top right.

Bearing in mind this circumstance, the manufacturers may be congratulated on the performance of the set without an external aerial. In addition to the two Brookmans Park transmissions and 5GB, six foreign stations were received on the medium-wave range after dark at good programme strength, Turin and Rome being outstandingly good. It is difficult to give figures for selectivity, but as a rough guide it was noted that 5GB occupied a band of about 5 degrees on the 100-degree dial and London Regional 15 degrees at a distance of five miles from Brookmans Park. Incidentally, the production models will be calibrated in wavelengths, and the dial illuminated by a pilot lamp. Selectivity may be increased by turning down the volume control and increasing reaction. The volume control varies the screen-grid potential of the H.F. valves, and when this is decreased the impedance of the valves is raised, giving less loading of the tuned circuits and increased selectivity.

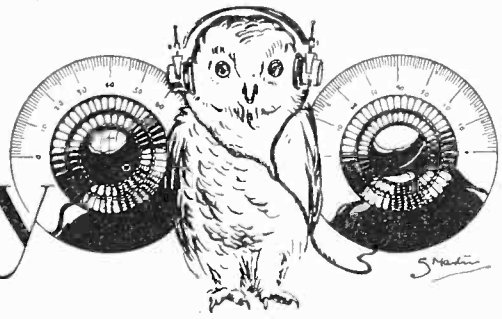
The long-wave range can be relied upon to produce six or seven stable programmes, either in daylight or after dark. The selectivity on this range is more than sufficient to separate 5XX from Radio Paris, but a slight background from Daventry could not be eliminated when receiving Königswusterhausen in North London. In the particular model tested, only about two-thirds of the volume control could be usefully employed, as the top section of the dial produced too high a screen-grid voltage for stability. However, a good minimum was obtained, and the principle of volume control adopted is justified, since it gives considerable latitude for variations in the characteristics of the screen-grid valves.

The receiver is mounted on a pedestal running on rubber-tyred castors, which contains a Peter Grassman moving-coil loud speaker, complete with rectifier for energising the field winding. The quality of reproduction from this speaker is distinctly above the average, and precise measurements would be necessary to detect any faults which might exist; they are certainly not appreciable to the ear.

The cabinet work is of a high standard, the normal finish being in burr walnut with quartered panelling, and the price of the complete instrument, including loud speaker, is £58 18s. The price of the set alone is £40.

The makers' new address is Radio Instruments, Ltd., Madrigal Works, Purley Way, Croydon.

WIRELESS THEORY SIMPLIFIED



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

(*Continued from page 68 of previous issue.*)

THE THREE-ELECTRODE VALVE.

AS early as 1907 Lee de Forest of America interposed between the filament and anode of Fleming's valve a metal grid or mesh with the object of controlling the stream of electrons passing from the hot filament to the plate, thus inventing the three-electrode valve or triode. He realised that the free electrons representing the space charge in the gap between the plate and filament produced an electric field which exercised a considerable controlling effect on the current passing, and that if this field could be altered in strength at will by superimposing on it another field under complete control, the current might be varied as desired.

The third electrode or grid was therefore placed close to the filament where the normal space charge is most intense, and by applying different potentials to the grid the space charge could be counteracted to varying degrees. By this means it was found that the plate current could be controlled over the whole range from zero to the saturation value represented by the maximum possible emission from the filament. The third electrode must necessarily be in the form of an open grid or mesh so that the electrons issuing from the filament can pass through the interstices and reach the plate.

The simplest type of three-electrode valve is one in which a straight filament lies along the central axis of a cylindrical anode or "plate" (some of the earliest valves had flat anodes, hence the name "plate," which is still used to a large extent no matter what the shape of the anode might be). The grid consists of an open helix or spiral of wire surrounding the filament and also centrally arranged with respect to it. An arrangement of this description is shown in Fig. 1 (A). As the characteristics of a valve depend to a very large extent on the geometrical arrangement of the electrodes a great variety of designs is to be found among modern valves. For instance, one important class employs, instead of a single straight filament, an inverted "V" or an "M" shaped one enclosed by a flat-shaped anode and grid, an example being shown in Fig. 1 (B).

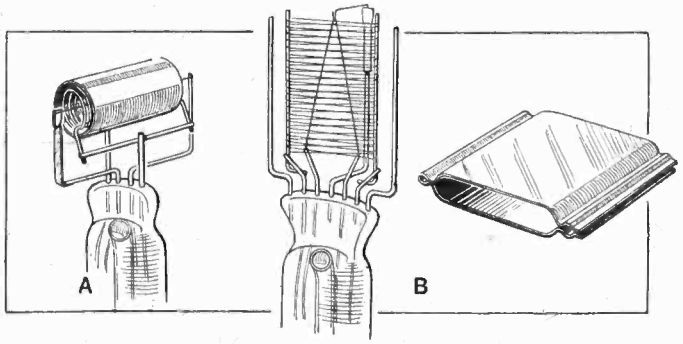


Fig. 1.—Simple types of three-electrode valve. (A) Straight filament and cylindrical anode. (B) V-type filament and flattened anode.

General Properties of the Triode.

When the filament is heated and a moderately high positive potential is applied to the anode by connecting a suitable battery between the anode and the filament, electrons emitted from the latter are attracted across the vacuous space and pass through the openings in the grid on their way to the anode. The intensity of the electric field in the vicinity of the grid depends not only on the number of free electrons in that space, but also on the potential of the grid relative to that of the filament. Since the potential of the filament itself is not the same at all points along its length owing to the potential difference applied to its ends for heating purposes, it is usual to refer the potentials of all other electrodes to the negative end of the filament. Where the cathode is independently heated by a separate heating element as in A.C. valves, all points of the cathode are at the same potential and the above stipulation is not necessary.

For a given valve the anode current, represented by the electrons getting through to the plate, depends on the anode voltage or plate potential and on the voltage of the grid relative to that of the filament, provided of course that the maximum or saturation current has not been reached. The general performance of a valve can be fairly accurately determined from curves showing the relationship between the anode current and voltage with a fixed value of grid potential (usually zero) and between the anode current and grid potential with a fixed value of anode voltage, the filament or heater voltage being maintained constant at the normal rated value. Such curves are referred to as the static characteristic curves of the valve, the term "static" being used because the various voltages and currents are constant when the readings are taken.

Wireless Theory Simplified.—

Circuit for Obtaining Valve Characteristics.

A suitable circuit for determining experimentally the static characteristics of an ordinary three-electrode valve of the filament type is given in Fig. 2. The filament is heated by a "low-tension" battery A, preferably a lead accumulator, and the anode is maintained at the required positive potential by means of a "high-tension" battery B, capable of supplying a current somewhat greater than the saturation current of the valve. The terms "low tension" and "high tension" are applied to the batteries A and B respectively because A is a low-voltage battery for filament heating only (2, 4 or 6 volts), and B is a comparatively high voltage battery giving 50 volts or more according to the requirements of the valve to be tested, but capable of supplying a few milliamps of current only.

A variable resistance or "filament rheostat" R is included in the filament circuit to enable the voltage to be adjusted to the correct value with the aid of the low-reading voltmeter V_f. A high-reading high-resistance voltmeter V_a is connected between the negative end of the high-tension battery and the positive tapping point which leads off to the anode of the valve. This voltmeter must have a high resistance in order not to cause an unduly heavy drain of current from the high-tension battery. A suitable voltmeter is one with a resistance of 200 ohms per volt, and would take 5 milliamps only, when reading maximum voltage. The milliammeter mA. must be connected in the position shown and not at X, where it would read the sum of the currents taken by the valve and the voltmeter V_a.

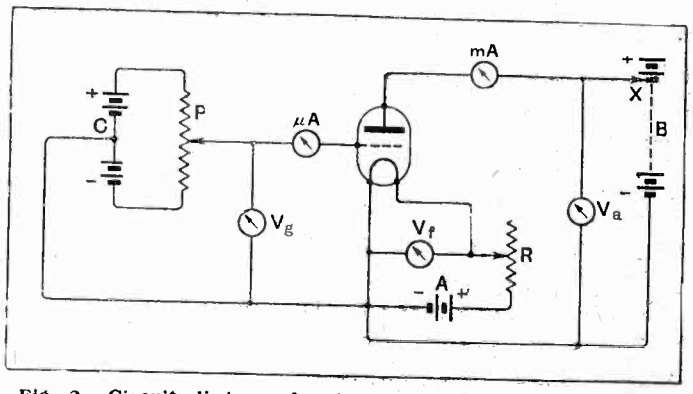


Fig. 2.—Circuit diagram for determining the static characteristics of a three-electrode valve. The positions of the instruments in the circuit should be as shown, so that the voltmeter currents do not affect the readings of the milliammeters.

Now as regards the grid circuit: It is necessary to be able to vary the grid voltage through a suitable range from several volts positive to several volts negative with respect to the negative end of the filament. This can best be accomplished by joining the mid point of a battery C to the negative "leg" of the filament and by connecting a high-resistance potentiometer P across the ends of this battery. The grid of the valve is then connected to the slider of the potentiometer with a microammeter μA in circuit for indicating any current which may flow to the grid. The potential of the grid with respect to the negative end of the filament is measured by the voltmeter V_g.

Obtaining the Anode Voltage/Anode Current Characteristic.

In conducting the measurements, the first step is to adjust the filament voltage V_f to the correct value by means of the resistance R. To obtain the curve of anode current plotted against anode voltage with the grid maintained at zero potential either adjust the slider on the potentiometer P until V_g reads zero, or, better still, remove the grid battery C and the potentiometer temporarily and connect the grid directly to the negative end of the filament. Then take readings of V_a and mA. for various tapping points X on the high-tension battery B.

On plotting the curve it will be found to be very similar in shape to the characteristic curve of a diode or valve without a grid, but the actual values of the anode current will, of course, not be the same with the grid present as without it, even though the dimensions of the filament and plate are the same in each case. A typical curve obtained in this way for what is termed a "general purpose" valve is given in Fig. 3, the grid having been joined permanently to the negative end of the filament during the time of making measurements.

It will be noted that the slope of the curve at first increases as the anode voltage is raised from zero, but that over the middle range the curve is almost straight, the slope being nearly constant. Near the top the slope becomes less steep again until, when the saturation current is reached, the curve becomes horizontal. It will be shown subsequently that the slope of the curve over the straight part yields very important information regarding the resistance of the valve.

Plate to Filament Resistance.

The whole of the power coming from the high-tension battery B in Fig. 2 is expended within the valve because there is supposed to be no resistance in the external anode circuit. For instance, if I_a is the anode current indicated by the milliammeter mA., and V_a the voltage between the anode and the filament, the power given to the valve is $V_a I_a$ watts, and is expended inside the bulb. The energy represented is converted into heat in the valve and, therefore, in effect, the valve possesses internal resistance between the filament and the plate, because, according to the laws of ordinary circuits, heat can only be produced by a current when resistance is present. But the space between the filament and plate is a vacuum, and a vacuum has infinite resistance; it cannot *conduct* any current whatever. The electrons come across free in space, and, therefore, *no heat can be generated in the space between the anode and the filament or cathode.*

It is clear, then, that our ideas of resistance as applied to material conductors cannot be applied in the case of a valve. We know that something equivalent to resistance is present because energy is absorbed from the high-tension battery and converted into heat which raises the temperature of the anode itself. When the anode voltage is raised sufficiently the anode becomes red-hot in many valves. We shall see later that

Wireless Theory Simplified.—

the equivalent internal filament to anode resistance of the valve usually amounts to some thousands of ohms, and a high resistance of this order cannot possibly exist in the metal of the plate itself. The first questions to be settled then are how the heat is generated, and how it comes to be accumulated on the anode.

The electrons which leave the hot filament would never reach the anode if the latter were not given a positive potential; it is this positive potential which accelerates the freed electrons and draws them on towards the anode. Now, as already mentioned in a previous section, in spite of its infra-microscopic dimensions (if it has dimensions at all), an electron is known to possess a certain amount of mass or inertia, that is to say, a force is necessary to increase its velocity or accelerate it, just as a force is necessary to set a material body in motion. When a body is accelerated or set in motion a certain amount of energy is expanded during the process, and this energy is stored in the moving body. Energy in this form is known as kinetic energy, or, in other words, energy of motion; it is proportional to the mass of the body and to the square of the velocity.

Thus in our valve the energy coming in from the H.T. battery is directly employed in accelerating the electrons emitted from the filament, and is stored as kinetic energy in the moving electrons crossing the vacuum. As yet there is no generation of heat—merely the production of motion. By the time the electrons reach the plate they have acquired an enormously high velocity which can be calculated in terms of the voltage. They collide violently with, and are brought to rest by, the anode itself, and in so doing give up their kinetic energy which is converted into heat at the anode, resulting in a rise of temperature.

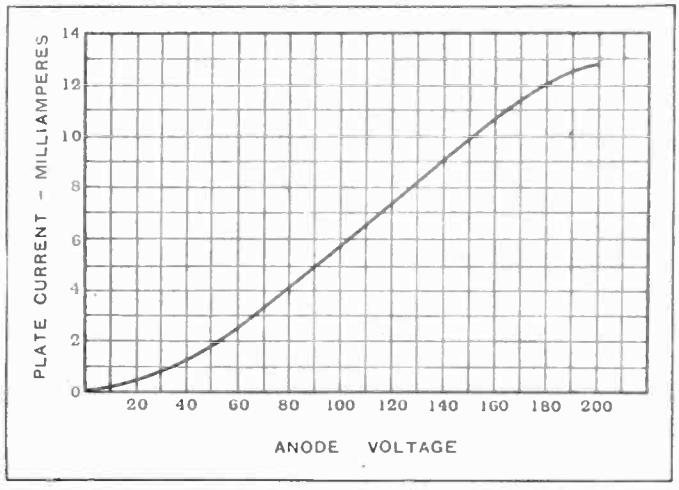


Fig. 3.—Anode voltage/anode current characteristic of a general purpose valve taken with the grid potential set at zero.

The principle can be roughly illustrated by an armour-piercing shell fired from a gun, the energy required for penetrating the armour being carried as kinetic energy by the high-velocity shell. When the latter strikes the armour there is a great generation of heat, causing a temperature rise sometimes high enough to cause localised melting of the steel.

We can conclude then that the heating which occurs at the anode of a valve *is not due to resistance at all*, but that it is simply the result of the collision of countless numbers of high-velocity electrons with the anode. The energy taken from the battery is first given to the electrons in overcoming their inertia, or *mechanical* resistance, to motion as they are accelerated, and then as each electron strikes the plate it gives up its kinetic energy which is there and then converted into heat.

If the anode voltage is very high the electrons strike the plate with extremely great velocity, and the molecules at the surface being bombarded may be so violently agitated that they themselves throw off electrons again with sufficiently high velocity to drive them back to the filament, thereby reducing the anode current. This is known as secondary emission.

Knowing how the heat is generated in the valve; that it is not due to resistance as ordinarily defined, we are now in a better position to interpret clearly the meaning of the anode voltage/anode current curve of Fig. 3 in relation to the equivalent internal resistance of the valve.

(*To be continued.*)

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.

RADIO SERVICING.

Sir,—With reference to the letter from Mr. R. V. Jones published recently, I suggest that he, like a good many more, buys his radio goods where prices are cut. In this case he cannot expect service. If, on the other hand, he has always paid full price, and not obtained service, then I say without hesitation that his knowledge of the radio retailer is extremely small.

A friend of mine the other day asked me to look at a Marconiphone portable which he had purchased that afternoon. It refused to function. I asked him where he had purchased it, and he said a music dealer. This particular music dealer sells portables but has no experience of radio, and it is a common practice of his to hand out sets with run-down batteries, etc., not really knowing how a portable functions and that batteries are necessary. I fancy he thinks they are like gramophones—want winding. If the public will not patronise proper radio shops who do not cut prices, then I cannot see how they can logically expect service. The proper radio shop is, I agree, in the minority, but, as manufacturers in general take no steps to prevent price-cutting, and as price-cutting with service does not pay, then, *ipso facto*, the man who expects something for nothing cannot expect service. B. GLADSTONE.

London, S.W.

Sir,—I am interested in the letters appearing in your correspondence columns *re* "Radio Service."

I should like to suggest, as a fact, that the radio retailer, taking the average, has to cut prices to do a fair trade, and that this brings customers who could not otherwise afford wireless. Service is not possible under such conditions.

I think that the largest sales were made by the big adver-

tising of valve manfacturers in 1928-29; this gave an impetus to the whole trade.

Mr. A. Dunnett is not concerned with the wireless trade as a whole, and this is the point that matters; moreover, to attempt to gain knowledge of the customer's requirements when he knows not what they are, and to weigh the *pros* and *cons* of what is best for the intending customer, is almost certain to cause him to suspect lack of knowledge. The man who knows little or nothing about wireless is the best salesman for the general public.

Every statement made by Mr. Dyer, of the Wireless Retailers' Association, I regard as correct, and as a true statement of things as they are.

As mentioned in the first part of this letter, things could be made to "hum" again with big advertising. The retailer who can "service" will not put radio on its legs.

London, S.E.11. G. A. RYALL.

Sir,—Mr. R. V. Jones's statement in your issue of the 9th inst., that members of the W.R.A. should be compelled to pass a qualifying examination, seems a little unnecessary.

As Mr. Jones no doubt realises, the theory and practice of radio cannot be learnt in a week or two to reach an examination standard, and how many dealers can spare a lengthy period to concentrated study for an examination, granting that they need it, as Mr. Jones implies?

The average dealer has sufficient radio knowledge to enable him to diagnose faults in home-built receivers, but with the factory-built receivers the question is usually much different, owing to the less open construction of the set.

It is on the commercial set that the dealer needs instruction as to its construction and performance, including rectification of possible breakdowns.

The Marconiphone Company is leading the way to the solution of this problem, and complete satisfaction of the buyer of a radio receiver is not only instructing the dealer in the construction of their receivers and diagnosing faults, but how and why the various components function.

Such a system of training is bound, not only to lead to a strong group of efficient radio retailers, but also to a satisfied public who will go to its dealer with the same confidence as it visits its doctor. C. ALEXANDER HOWARD.

INTERFERENCE WITH THE RECEPTION OF RADIO.

Sir,—The subject named has been one of much controversy, but I feel that the time has arrived when steps should be taken so that the matter may be dealt with on the same lines and under the same statute as other nuisances.

At the moment the position is as set out in a letter before me from "The Engineer in Chief" of the G.P.O.

"I am directed by the Postmaster-General to say that he has no statutory powers under which he could compel the owner of electrical plant causing interference with wireless reception to remove the cause of the interference."

Now I do not profess any legal knowledge, but speaking as a layman I must say this does seem to represent a remarkable state of affairs. I myself am particularly interested in the reception of programmes which, as far as I am aware, do not entail any expense on the part of our Post Office beyond the cost of issuing a licence, and yet, having received the licence fee, they admit they cannot take such steps to deal with interference as would enable me to receive that for which I have taken out a licence to receive. I am aware that a gun licence does not carry with it the provision of birds to shoot, but the two cases are not parallel. The matter could be argued under the heading of "causing a nuisance" because, should my neighbour install, say, a petrol electric plant, the exhaust from which caused annoyance, I could obtain an injunction to refrain him from continuing the annoyance, but, say, in the case of a badly sparking commutator, which would prevent or interfere with wireless reception, I am powerless to prevent it.

One could quote cases *ad lib.*, but my object in writing is not necessarily to start a controversy, but rather so that those interested in the matter can think out collectively or individually what steps may be taken to deal with the situation. Wireless reception has become part of our daily life, and, sooner or later, there must be legislation to deal with such matters as needless interference. I believe it would help in the meantime if those interested would take the matter up direct with whoever may be their Member of Parliament.

This would at least help by indicating the feeling of the listening public and prepare the ground for such time as the case may be mentioned in the House.

JAMES NELSON, M.I.E.E.,
Institute of Wireless Technology.

71, Kingsway, W.C.2.

Sir,—On page 25 of *The Wireless World* of July 2nd, mention is made of C. E. Board's 132,000-volt supply, and possible interference. In September last I built the "Foreign Listener's Four," and as was to be expected the results were all that one could wish for. I am situated midway between two towers carrying the 132,000-volt lines between Glasgow and Bonnybridge on the Glasgow-Edinburgh line. This section was energised 14 months ago (May, 1929), and from then till September, 1929, I was using a Det. 2LF set and experienced no trouble. When using my "Foreign Listener's Four," the interference from the overhead lines on wet or foggy nights is so bad as to completely wipe out or distort all stations other than the Local (5SC), which is only received at 50 per cent. normal strength, and accompanied by a machine-gun rattle. The noise from the towers reminds one of the preparation of the Sunday morning's eggs and bacon. I have been in touch with others who use a H.F. Det. 2LF set and they complain of the same trouble, but those with Det. 2LF sets do not experience the trouble to the same extent. On a dark and moist night the insulators from a distance of 100 yards appear illuminated, the sparking and crackling over the insulators being heard clearly at that distance. A. CAMERON.

Glenboig, Lanarkshire.

DUPLICATING 5XX.

Sir,—Until quite recently I resided at Bournemouth, and, in common with Mr. Lucas, I agree that 5XX is THE only station which can be relied on for really consistent reception. I notice he states he has never had the good fortune to hear the local station. I am inclined to query his good fortune if my experience is anything to go by. At one time I lived within a quarter of a mile of 6B.M., and, of course, there I was absolutely swamped. BUT the output at times was appalling. Signal strength varied enormously, and when at times gramophone records were "put over" from the local studio the quality was comparable with an ancient phonograph.

Now take the case of a friend of mine living at Swanage. His is a three-valve set, S.G., det. and pentode. Here 5XX is THE only station on the British side one can listen to with any degree of certainty; 5GB is utterly useless as an alternative. Fading is terrible. Brookmans Park is the same. Of course, Bournemouth comes in with a thump, being only eight miles away. But quality and consistency is lacking. Tune up to 5XX, however, and he comes through night and day, never varying. How about an alternative programme, though? One must go over to France for that. All the French stations come in admirably, particularly Toulouse. I can assure the B.B.C. that, were they to duplicate 5XX, they would earn the gratitude of all the people who at present rely *entirely* on that station for their British reception. I would ask them: Why must South Coast dwellers look to foreign countries for their alternative programmes? L. J. DAVIS.

London, S.W.15.

MIDLAND REGIONAL WAVELENGTH.

Sir,—I read with amazement in your issue of July 2nd, under "Broadcast Brevities," that the B.B.C. intend to move the Midland Regional down to 377 metres. As one can only just receive Toulouse in the London area without interference from the London Regional station, what is to be the position when we attempt to receive the Midland Regional Station upon its proposed new wavelength? The B.B.C. has blotted out Cologne, Nurnburg, practically Turin, and now Toulouse will be impossible. Why do they not settle down on Rome's doorstep and then discontinue the publication of *World Radio*?

Highgate, N.6. G. F. H.

Dissatisfaction in Aberdeen.

The number of licences in the city of Aberdeen is diminishing as many listeners complain that, since their local station is now little more than a relay station taking its programmes from London, the Scottish quality has disappeared. Many users of crystal sets have allowed their licences to lapse, and the number of listeners is stated to have dropped by over 1,400 since last September. Mediocre London vaudeville is considered a poor recompense for the loss of the rich Scottish humour they used to get, and the Aberdonians say that it is no good a Londoner selecting a programme for Scottish audiences.

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Mr. Lewis' New Duties.

Though Mr. Joseph Lewis, the musical director of the Birmingham Studio orchestra, has now joined the headquarters staff at Savoy Hill, I understand that he has not entirely forsaken Birmingham. His present position is that of a consultant in matters concerning musical programmes and assistant to Dr. Adrian Boult as a conductor. He will probably travel frequently between the two cities, conducting sometimes in London and sometimes in Birmingham.

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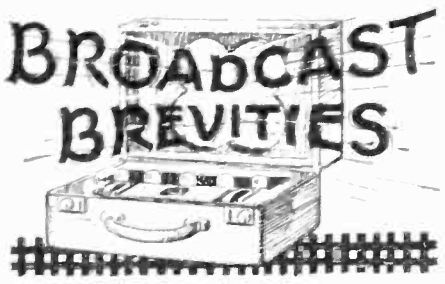
Another Woman Announcer.

The Birmingham studio, incidentally, has followed the example of other provincial stations in appointing a woman announcer. Last week Miss G. Ward, a member of the studio staff, went through her first ordeal in this capacity during Miss Josephine Tucker's broadcast, when she announced the titles of that artiste's songs. Miss Ward will probably fill the duties of announcer at week-ends and as a holiday relief.



By Our Special Correspondent.

Manchester has had a woman announcer at intervals for some considerable time, but there is no indication at present that Savoy Hill intends following suit.

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Announcing Made Easier.

Announcing nowadays is far more cut-and-dried than in the earlier days of broadcasting, and does not call for the same initiative and ability to cope with any emergency that was required in times past, in fact, announcers are now invariably furnished, as a matter of routine, with a written copy of everything they have to say.

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Scottish Regional Station.

In spite of the regular daily rumours that the B.B.C. has decided upon a site for the Scottish Regional Station it is by no means certain that the necessary conditions will be met with in the site at Falkirk, which has been so frequently mentioned.

The test holes which have been dug have not yet revealed that the soil will be suitable for a broadcast transmitter; one boring has disclosed a subsoil composed of a mixture of clay and gravel, while another has shown pure sand, whereas the soil required should be either solid clay or unmixed gravel, it will, therefore, be necessary to dig further holes to ascertain whether the mixtures found are merely pockets, or representative of the whole site tentatively chosen.

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An Entomological Surprise Item.

Savoy Hill has had many strange visitors, but even stranger than the mosquitos which were broadcast some two years ago were the cicalas which Mr. Hugh Wain brought to a studio the other night as a surprise item. These "winged chirping insects"—to quote the definition given in the smaller Oxford Dictionary—now share the pride of place with dogs, sea lions, and serpents, but perhaps none are so realistic as the cylinder of compressed air used by Victor Hely-Hutchinson in his orchestral music for Karel Kapek's R.U.R.

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Zoological Studios.

Some years ago the B.B.C. conceived the idea of broadcasting the roar of a real lion from the studio, and arrangements were made accordingly, but the initial difficulty of getting the king of beasts into the studio had been overlooked, and this item of the programme had to be abandoned. I do not know whether the architects are making any special provision for extraordinary surprise items in their plans for Broadcasting House, but understand that in the new building to be erected in New York there is to be a specially large lift—elevator I should say—capable of conveying an elephant to the studio if his services should be required.

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The Birthplace of Mozart.

During August three relays of Mozart's music from his native town of Salzburg will be undertaken. On August 7th his Serenade will be heard by British listeners, on August 20th the first act of "Iphigenie" will be transmitted, and on August 30th an orchestral concert. This will be the longest line relay yet undertaken from the Continent, as the route *via* Stuttgart to London involves 1,700 miles of line, and at intervals no fewer than 21 repeaters will be installed to provide good quality in the transmission.

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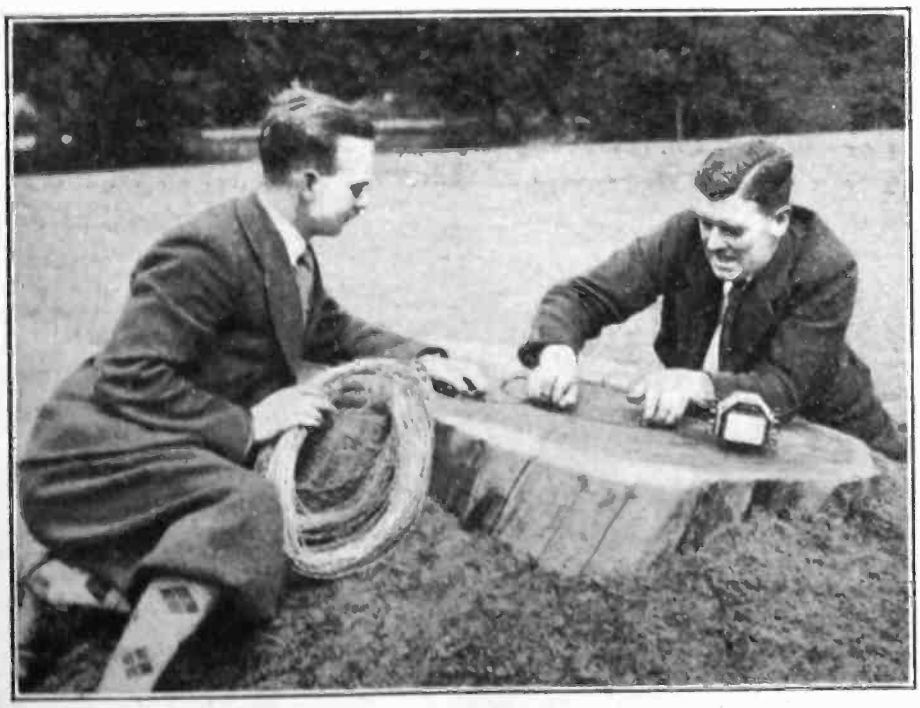
Radio Drama for the Midlands.

Is Radio Drama making the progress that was expected of it? The anxiety expressed by Mr. Percy Edgar, director of the Midland Region, regarding the dearth of plays suitable for broadcasting is, no doubt, pretty generally felt in other centres. Mr. Edgar has issued an invitation to play writers to submit plays which are likely to appeal to Midland audiences. "Plays in dialect," he says, "will be considered, but they must be short and must have definite local interest." What is required is to arouse interest by the spoken work alone in the presentation of situations, and attention should be given to the creation of thrilling melodramatic incidents while subtlety which can only be fully brought out by action and gesture should obviously be avoided.



CAMOUFLAGING THE MICROPHONE. To give listeners the impression of being actually among the 6,000 performers during the presentation of the Warwick Pageant the microphone was concealed within the false centre of a large tree stump.

READERS' PROBLEMS.

"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.

A "Gassy Valve.

I have just noticed that there is a distinct blue glow, apparently between grid and filament, of one of my valves. This, I suppose, is an indication of softness. Do you recommend that the valve should be replaced? D. N. J.

You would, we think, be well advised to change this valve, as "softness" is undesirable for several reasons. A valve in this condition is in any case likely to consume an unnecessarily high value of current from the source of H.T. supply; if used as an H.F. amplifier, it will be responsible for a certain amount of unnecessary loading of the preceding tuned circuit. If the valve operates as an L.F. amplifier, distortion will inevitably be produced.

o o o o

Pentodes on Short Waves.

Is there any reason why a pentode should not be used as an output valve in a receiver intended solely for the reception of the ultra-short waves? My object in proposing to use one is to obtain rather more L.F. magnification than is afforded by the usual single-stage amplifier with a triode output valve. W. G.

A pentode works quite satisfactorily in a short-wave set, and was, indeed, used in the S.G. Short-Wave III, described in *The Wireless World* of January 1st. No special precautions need be taken.

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A Mysterious Click.

I have for some time been puzzled by the fact that a distinct click in the loud speaker is produced when the H.T. battery of my portable receiver (H.F.-det.-pentode) is connected, even if the filaments are switched off. The loud speaker is directly in series with the anode, and it seems to me that this click must indicate poor insulation somewhere, as I can see no normal path for current when the valve filament is cold. Careful tests have been made, but I am unable to locate any fault, and the insulation of the output valve-holder, which would naturally be suspected, appears to be perfect everywhere.

Do you think that the click is an indication of some minor fault, and, if so, will you please make a suggestion as to where I should look for it? D. W. S.

We do not think that your receiver is at fault. In a portable set, particularly when a pentode valve is used, it is quite usual to connect a by-pass condenser of sometimes as much as 0.005 mfd. in the output valve anode circuit: to restrict the passage of stray H.F. currents through the loud speaker leads, etc., this condenser is generally joined directly between plate and filament. If this arrangement is included in your own set the completion of the H.T. battery circuit will have the effect of charging up the by-pass condenser; the charging current must of necessity flow through the loud speaker windings (see Fig. 1), and will produce a click.

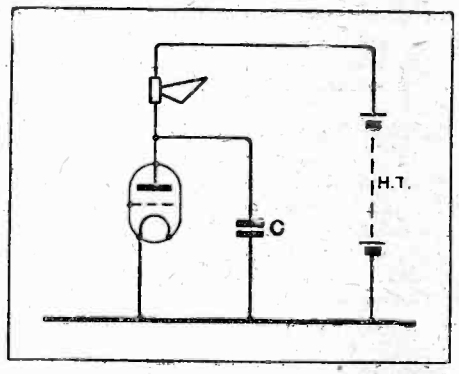

Fig. 1.—Charging current for the by-pass condenser C flows through the loud speaker windings.

If an examination of your receiver shows that our assumption is incorrect, and that there is no by-pass condenser, please write to us again, sending, if possible, a complete circuit diagram.

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The Dual Unit Loud Speaker.

In the article describing a double-cone loud speaker in "The Wireless World" of June 18th I can see no mention of the make of cone chassis which carries the Ediswan unit. Will you please tell me the name of the make of the chassis actually used in the instrument as described? M. L. C.

A standard Ormond chassis was used in conjunction with the Ediswan drive unit.

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Insoluble.

I have a 50-volt house-lighting plant, and am thinking of using this source of supply for heating the filaments of my valves, interposing a suitable resistance for "breaking down" the voltage. Will you please tell me the correct value for this resistance? Six-volt valves are used. B. W. P.

To answer this question, it is essential for us to know the current consumed by the valves at their rated voltage. You do not give us this information, but you can, however, easily calculate the value of the necessary resistance (in ohms) by dividing 44 by the value of this current, expressed in amperes.

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True Readings of Eliminator Voltages.

Although it has been stated in your journal that a voltmeter when used for measuring the output of an eliminator can only give an approximately true reading when the current consumed by it is very small in comparison with that normally passing in the circuit across which it is connected, I believe that I am right in saying that under certain conditions the meter can give an absolutely true reading (provided, of course, that it is accurate). If the meter remains connected in position, is it not a fact that it should register accurately the true voltage existing between the points across which it is joined? A. S. T.

Yes, this is quite correct; the voltage as indicated by the voltmeter will be correct under these conditions, but will be subject to a change—of unknown magnitude—when the load imposed by the instrument is removed. Of course, this change can be avoided by connecting in place of the meter a resistance having exactly the same ohmic value as its windings.

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Heating Batteries.

Is it likely that any serious difficulty would be encountered in modifying the Band Pass Four receiver in order that the heaters of the valves could be fed from an accumulator? It is proposed to use D.C. mains in conjunction with a small accumulator battery for H.T. supply. D. H. T.

No difficulties are likely to arise in making these modifications, but an accumulator of adequate capacity must be used; to prevent appreciable voltage drop in the leads, extra heavy cable should be used for wiring the heater circuits.

You will probably wish to use a two-cell L.T. battery; if so, it will be convenient to substitute P.X.4 valves for those specified for the output positions.

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.

 Advertisements for "The Wireless World" are only accepted from firms we believe to be thoroughly reliable.

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 ——— 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 issue of "THE WIRELESS WORLD" for August 6th must be closed for press earlier than usual.

MISCELLANEOUS ADVERTISEMENTS for insertion in that issue can be accepted up to

FIRST POST WEDNESDAY, July 30th.

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

OSRAM Music Magnet, assembled, £6; Lissen 2-valve portable, A.C. mains, £7/10; both complete with valves, perfect.—62, Greenfield St., Commercial Rd., E.1. 'Phone: Bishopsgate 4593. [1018

ALL Mains 3-valve Set, new, good components, £10; *Wireless World* back numbers, June, 1929, to July, 1930, 7/6.—Collett, 39, Shirley Rd., Addiscombe. [1014

LARGE Celestion Speaker, 24in., in oak, cost about £21, £8/10 for quick sale, can be heard by appointment; also Marconiphone 6-valve receiver, model 61, 6v., £18.—Hoather, Bushey Heath, Herts. [1013

ELSTREE Six for Sale, all components as specification, coils both wave lengths, 2v. valves; best offer.—Box 6821, c/o *The Wireless World.* [1006

McMICHAEL Super Range Portable, new, used few demonstrations only; sacrifice, £15/15.—Bell's, 45, Newington Butts, S.E.11. [1003

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. [0225

SUPERHET 7-valve, finest quality throughout, superb tone, over 40 stations on frame aerial, complete, minus speaker; £10.—Glanville, 129, Love Lane, Mitcham. [1045

3V. Set, S. G. and Pentode, dual range, Exide H.T. L.T., trickle charger (220v.) speaker, £8; another 3v. speaker, £4.—Bryant, 2, South Ridgway Place, Wimbledon. [1044

SCREENED Grid Pentode Receiver, battery or mains, cheap, new; also components and valves; send list.—L. M. H., 6, Alcester Rd., West Derby, Liverpool. [1039

5-VALVE Suitcase Portable, excellent tone, good range, new, £6/17/6; also cabinet loud-speaker, 17/6.—Gray, 55, Larkswood Rd., South Chingford. [1038

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 (London), Ltd., 105, Torriano Av., N.W.5. 'Phone: North 0623-4-5. [8751

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

RADIELLE D.C.100 (200-250 D.C.), output 200 volts 100 m.a., and 2 variable tappings; cost £9/10, sell £2/5; brand new; send c.o.d.—Priestley, 8, Grosvenor Gardens, Muswell Hill, London, N.10. [1012

IGRANIC Combined H.T. Supply Unit and Accumulator Charger from A.C. Mains, universal 110-220, 200v. 30 m.a. output; charges 4v. accumulator; complete with both rectifying valves; cost £16, price £8; 2PM 24A valves.—Percy, 20, Bond St., Ealing. [1033

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

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

ELIMINATOR for Sale, for D.C. mains, voltage 220; —Write, or call after 6 p.m., Mr. P. Seales, 29, Pandora Rd., West Hampstead. [1007

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