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Editor:
HUGH S. POCOCK.

Editorial, Advertising and Publishing Offices:
DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.

Telephone: Waterloo 3333 (50 lines).
Telegrams: "Ethaworld, Sedist, London."

COVENTRY: Hertford Street.
Telegrams: "Autocar, Coventry." Telephone: 5210 Coventry.

BIRMINGHAM:
Guildhall Buildings, Navigation Street, 2.
Telegrams: "Autopress, Birmingham." Telephone: 2971 Midland (4 lines).

MANCHESTER: 260, Deansgate, 3.
Telegrams: "Iliffe, Manchester." Telephone: Blackfriars 4412 (4 lines).

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

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Few or Many Valves?

British Radio at the Cross-Roads

WHETHER or not you were able to go to this year's Exhibition at Olympia you have by this time, no doubt, a pretty good idea of the new season's receiving sets in general and very possibly you have wondered within yourself what the future of British radio is going to be. Are we progressing in receiving set design and manufacture? If so, is our progress as rapid as it should be and is it entirely in the right direction? Everyone must find his own answers to those questions, but few, we think, will feel that the answers are one hundred per cent. satisfactory.

What may be called the standard receiver of to-day is a superheterodyne consisting of three—or, at the outside, four—" working " valves, plus a mains rectifier. The most usual layout is heptode frequency changer—pentode IF—double-diode-pentode AVC—*cum*-second detector-*cum*-output. From some points of view there is a very great deal to be said in favour of the set of this type. It can be sold at from £10 to £12 in two-waveband form, covering the medium and the long waves and from £12 to £18 as an " all-wave " receiver, taking in as well a short-wave band from about 15 to 60 metres. It will receive all the stations that are worth receiving on the medium and the long waves and, if it is an " all-wave " set, a considerable number of short-wave stations when conditions are favourable. It can have almost all the selectivity that is usefully employable; a measure of automatic volume control, and the output volume is sufficient for the ordinary living-room. But the outstanding advantage of the arrangement is that it enables the man of moderate means to purchase a receiver of very fair all-round performance. For that reason in particular the superheterodyne containing three or four complex valves is likely to continue in wide demand and it is only natural that it should figure largely in manufacturers' programmes.

But it is tragic that it should be almost the only kind of set—as distinct from radiograms—that the majority of them now make. Tragic, too, that the public should come to believe that £10 or so is as much as anyone should pay for a radio set. To put the matter bluntly there are only certain things that can be done with a limited number of multi-electrode valves and, so far as one can see, all of these things have already been done. In other words, there can be no real progress in receiving set design in this country until our manufacturers realise that they are not yet catering for a big market both here and in many parts of the Empire where the larger set with all possible refinements is in strong demand.

Limitations of Small Sets

The drawbacks to the use of a small number of complex valves are many. It is obvious, for instance, that to obtain the necessary over-all amplification every stage of the set must be screwed up to give the highest gain that can be obtained from it. Both this and the nature of the wiring connections required by such valves often leave a small margin of safety as regards stability. But the main objection is that almost the only refinements that can be introduced into such a set are good selectivity, fair sensitivity and automatic volume control, which must be limited in its action owing to the small number of valves to which it can be applied.

Editorial Comment—

Not uncommon difficulties in the small superheterodyne are background noisiness, self-generated whistles, oscillator wobble (particularly on the short waves), susceptibility to man-made interference (due to the absence of sufficiently complete screening) and last, but most important of all, poor quality of reproduction.

With few valves at his disposal the set designer must lay aside all thoughts of producing a receiver capable of showing anything like faithful reproduction. A large proportion of the total cost must be devoted to sensitivity. He knows that intending purchasers will insist that the set must be able to receive a large number of stations, even though most of those who buy will use it mainly for bringing in one or other of the local programmes. This is one of the curiosities of broadcast reception to-day. Any retailer will tell you that the first question asked by a prospective customer is: How many foreign stations will this set receive? Yet the average listener—in so far as there is an average listener—spends at least ninety per cent. of his "wireless time" with the receiver tuned either to local National or local Regional.

Bigger Sets Essential to Efficiency

To obtain high quality of reproduction is an expensive business from the manufacturer's aspect and it needs not few, but many valves. The man in the street does not demand high quality: so long as speech is fairly clear and music has plenty of bass he is satisfied—and it is comparatively easy to satisfy him with the moderately priced set, since he does not realise that there can be anything better. Unfortunately, perhaps, the human ear is extraordinarily accommodating. Those who have never heard genuine high-quality reproduction are content with something that falls far short of what it might be.

So long as British radio manufacturers suffer from their present three-valve complex as regards receiving sets and offer their larger receiving sets only in radiogram form, one cannot help feeling that they are missing a large and important potential market, partly because they underestimate the spending powers of the most prosperous nation in the world to-day, and partly because they have a fixed and apparently unshakable belief that the man who wants a first-rate wireless set will automatically buy a radiogram. Sometimes he will, but more often he won't.

What are the advantages of using many valves in a receiving set? They are manifold. Sensitivity—and this applies particularly to the short-wave range—can be brought up to something worth while. Noisiness and self-generated whistles disappear. Automatic volume control becomes far more effective. Quality of reproduction is enormously improved and *undistorted* output volume can be vastly increased.

All kinds of refinements can be introduced, refinements that are genuinely worth while but quite out of the question with a small number of valves. True QAVC is one of them, automatic tuning correction another, automatic contrast expansion a third. And there are many others. What it comes to, in a word, is that your designer can produce a receiving set incorporating the big advances in radio receiving technique that have been made in recent years, that he can keep pace with progress. These things cannot be done if he is limited to three or four already overworked multiple-electrode valves.

British radio stands at the cross-roads to-day. The time has come for those concerned to take stock of the position and to look to the future in planning their policy. Are they going to continue to blind their eyes to the demand for first-rate receiving sets that exists already in this country and would become so much larger if the public realised the possibilities of the set of many valves? Are they going to remain content with seeing the pages of radio journals published in many countries of the Empire filled with references to the foreign sets and advertisements of their virtues, to the exclusion of the British-made receiver? The bigger receiving set would not be for home consumption alone; it is exactly what is required to meet the Empire's demand.

Television

Inauguration of Service

ALTHOUGH still described as "experimental," the regular television service was opened by the B.B.C. last Monday and sufficient public interest has been aroused to justify the opinion that, so long as good programmes can be maintained, television will make steady progress towards a wider popularity. As readers are aware, the opening ceremony was conducted alternately by the Baird and the Marconi-E.M.I. systems, no doubt because it was felt that on such an auspicious occasion both concerns should be given an equal opportunity.

It is still difficult to understand why there should be two systems when by some arrangement the rivals might pool their technical knowledge, just as was done by various manufacturers in the early days of sound broadcasting. It is gratifying that a similarly happy position in the sphere of television was foreshadowed in the speech delivered by Lord Selsdon at the inaugural ceremony.

Broadcast Distribution

No Case for Proportional Representation

ONE of the strongest arguments against broadcast advertising as a national policy was disclosed in the course of a conference on station power recently held in the United States of America.

A speaker was complaining of the readiness of the broadcast licensing authorities to permit a constantly increasing number of stations to operate in those areas where the population was densest, resulting in the neglect of rural and less-populated districts. Broadcasting stations in America are run for profit, the profit coming from advertising revenue. Advertisers naturally tend to take "time" on the stations serving the largest number of listeners and then design their programmes to interest the type of listener they want to reach.

With our own broadcasting organisation or, in fact, any system which is independent of advertising revenue, the broadcasting service is planned to cover the whole country as evenly as possible and ensure that every district is equally well served. As soon as the principle of broadcasting supported by advertising is introduced, immediately the position is created that nobody wants to run a broadcasting station unless they can do so at a profit, and sparsely populated districts are neglected.

Incidentally, we have here yet another reason why it is desirable to suppress the idea still foolishly put forward, but fortunately at less frequently recurring intervals, that the broadcast licence fee of 10/- is in the nature of payment for a programme service as if it were a theatre ticket. If this were the position we ought at once to grade the licences as stalls, dress circle and gallery at different prices, according to whether the listener is or is not well within a service area, and various other considerations.

Wireless sets are popular because of the broadcasting service, but the licence fee certainly constitutes no sort of contract between the listener and the B.B.C.

Negative Feed-back Amplifiers

A NEW DEVELOPMENT IN HIGH QUALITY REPRODUCTION

THE attainment of a high standard of reproduction is by no means difficult in the case of equipment designed for operation from the AC supply mains, for it is easy to secure ample power in suitable form for the valves. The DC mains user, however, has hitherto been at a serious disadvantage for, although he can obtain plenty of power economically, it is at too low a voltage for the best use to be made of it. As a result, he has had to tolerate a considerably greater amount of amplitude distortion than his brethren having AC supplies need do.

This has now been changed, and the development of the negative feed-back principle has made it economically possible to build a DC mains amplifier which is strictly comparable from the point of view of quality with the best AC apparatus. The principle is not, of course, confined to DC sets, and should lead to a considerable improvement when applied to battery-operated equipment. Its advantages will also manifest themselves when it is used in AC equipment of the same type. They are, however, less important in this case, for there is no necessity to use this same type of equipment, and the high standard of quality required may be, and often is, obtained by other methods which are inapplicable to DC and battery apparatus.

The negative feed-back principle is by no means new, being developed by Black some years ago,[1] and has been used in communication work both in this country and in America; it is, however, only just finding application in broadcast reception. As applied to any individual stage of an amplifier, it means that a portion of the output voltage is fed back to the input so that it opposes the input voltage. The amplification of the stage is consequently reduced, but so are both amplitude and frequency distortion. Moreover, the effective output impedance is altered, and the input impedance may be also.

The Output Stage

Before the advantages of negative feed-back can be appreciated it is necessary to be familiar with the characteristics of existing amplifiers. The greater part of the distortion in well-designed equipment occurs in the output stage, and it is certainly this stage, more than any other, which worries the designer of DC and battery equipment. There are two general types of valves which can be used, the triode and the pentode.

The triode has characteristics such that the amplitude distortion which it introduces consists chiefly of second harmonics. These can be balanced out by the use of two valves in push-pull, and an output stage causing an extremely small degree of amplitude distortion can readily be obtained. Furthermore, the valves require a load resistance which is high compared with their own internal AC resistance, with the result that the dynamic valve characteristics are much straighter than the static. As a corollary of this, the loud speaker is heavily damped by the valve resistance, for in effect the AC resistance of the valves is connected across the output transformer primary, and is much lower than the impedance which the transformer presents to the valves.

A valve having an AC resistance of 1,000 ohms, for instance, usually requires a load impedance of some 4,000 ohms, and the transformer ratio is chosen to give this load. Looking backwards from the loud speaker, however, the speech coil is effectively shunted by one-quarter its own impedance (the valve resistance divided by the square of the transformer ratio), and is consequently heavily damped. The importance of this is evident when it is remembered that damping the loud speaker reduces the effect of resonances in the speaker at low audio frequencies.

In spite of its good characteristics from a distortion viewpoint the triode suffers from three disadvantages. Its sensitivity is low, that is, it requires a large signal input for its output; its grid bias is often as high as 12-25 per cent. of its anode voltage; its efficiency is fairly low, that is, only some 20-25 per cent. of the DC anode power can be converted into useful AC power for operating the loud speaker.

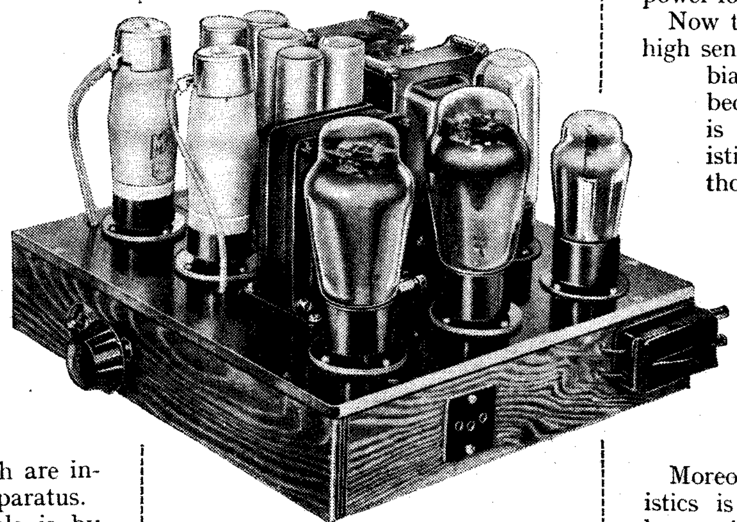
Now the pentode has the advantage of high sensitivity, a comparatively low grid bias and higher efficiency, and it is because of these advantages that it is so widely used. Its characteristics are not nearly as straight as those of a triode, however, and as the load impedance must be much less than its AC resistance, it exercises a negligible straightening effect on the characteristics. Because of this low load impedance, the valve does not damp the loud speaker appreciably, and speaker resonances are not reduced.

Moreover, the shape of the characteristics is such that both odd and even harmonics are introduced, and in consequence the use of push-pull is not of great advantage, while the magnitude of load impedance becomes quite critical.

In spite of its disadvantages, the pentode is widely used because of its high sensitivity, which often permits the saving of one AF stage. In the case of DC sets, however, there is little alternative because its low value of grid bias enables a higher anode voltage to be obtained, and consequently a greater output. With automatic grid bias, the bias voltage is necessarily subtracted from the HT supply, the available anode voltage being equal to the HT voltage less the grid bias. With DC mains the HT supply is limited, and must be less than the mains voltage by the drop in the smoothing equipment. After smoothing, there is often less than 180 volts available for the receiver.

It is easy to see that if out of this 180 volts some 20-30 volts must be used for grid bias, we shall be able to supply the output valve with perhaps 150-160 volts only for its anode. A pentode, however, needs only about 7 volts bias, with the result that an anode voltage of some 173 volts

By W. T. COCKING



THE negative feed-back principle is one of the most important of recent developments and its principles and applications are discussed in some detail in this article. It is in the output stage of AC/DC equipment that it seems likely to prove of greatest advantage, and elsewhere in the issue will be found an announcement of an amplifier incorporating the principle.

[1] Stabilised Feed-back Amplifiers, by H. S. Black. Bell System Technical Journal, Jan., 1934, and Electrical Engineering, Jan., 1934.

Negative Feed-back Amplifiers—

may be obtained. This increased anode voltage coupled with the somewhat greater efficiency of the pentode enables an appreciably greater output to be obtained.

It is clear that the main disadvantages of the pentode are the high harmonic content of the output and the high output impedance of the valve. If these can be overcome, then it will not suffer in a comparison with a triode, and may even have advantages over it. The use of negative feed-back enables some or all of the defects to be overcome, and thus it is a real contribution towards better quality.

Feed-back by Cathode Resistance

There are several ways of obtaining negative feed-back, but they do not all offer the same advantages. It is, therefore, necessary to consider them in some detail. One of the simplest arrangements is shown in Fig. 1 (a), and will be seen to consist merely of the omission of the usual bias resistance by-pass condenser. The resistance R is the bias resistance, and since the AC component of the anode current flows through it, AC voltages are developed across it. The input voltage of the stage is that which appears across the secondary of the input transformer, but this is not, as is usually the case, the voltage effective in operating the valve. This last is the voltage between grid and cathode, and is equal to the input voltage less the voltage across R.

If R were perfectly by-passed so that no feed-back took place, the voltage amplification between the input transformer secondary and the output transformer primary would be $\mu R_L/(R_a+R_L)$, where μ and R_a are the amplification factor and AC resistance respectively of the valve and R_L is the load impedance presented by the transformer. For simplicity this is assumed to be a resistance. When the by-pass condenser is omitted, as in Fig. 1(*a*) the gain becomes $\mu R_L/\{R_a+R_L+R(1+\mu)\}$. The gain is reduced in the same proportion as if the valve resistance were increased from R_a to $R_a+R(1+\mu)$.

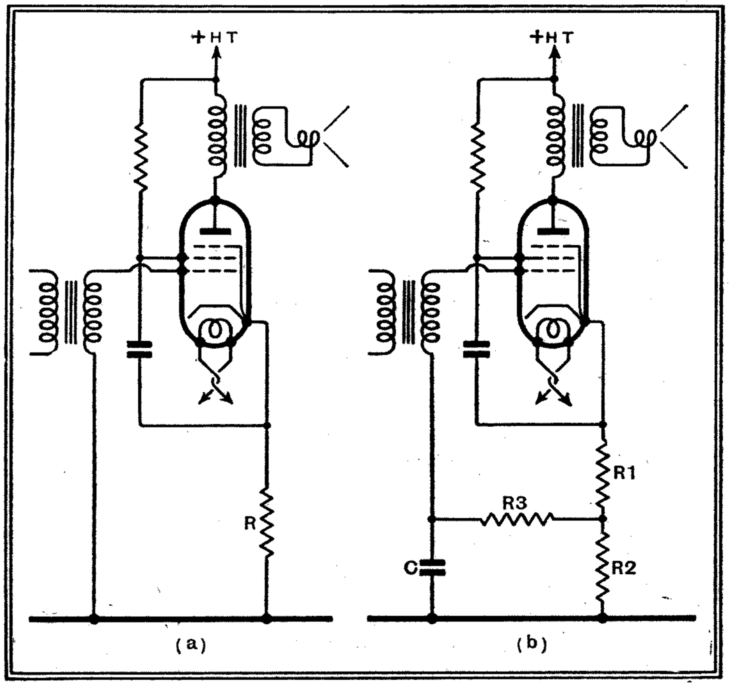


Fig. 1.—Negative feed-back is most readily applied by omitting the usual by-pass condenser across the bias resistance R as shown at (a). A greater amount of feed-back can be secured by adopting the connections of (b).

We have seen, however, that a high valve resistance is undesirable, and that the normal resistance of a pentode is too high. It would seem, therefore, that this circuit is undesirable, since it appears to increase rather than reduce the AC resistance. We must be careful in defining the AC resistance, however, for what we really want to know is the apparent output resistance R_o which would be measured between the output terminals when the output transformer is disconnected. This is the resistance which is effective in damping the loud speaker.

Assuming the grid to be shorted to the cathode, the value of R_o would obviously be $R+R_a$, but with the connections of Fig. 1(*a*) it is different because a change of anode current alters the grid voltage which in turn reacts on the anode current. Suppose we increase the anode voltage slightly, what happens? Obviously there is first of all an increase of anode current, and consequently a greater voltage across R. The cathode, however, becomes more positive than before with respect to the earth line, and hence the grid, so that the grid becomes more negative with respect to the cathode. This change in grid potential tends to reduce the anode current and so offset the original increase. The change in anode current for a given change in anode voltage is thus less than it would be if feed-back were absent, and the effective output resistance is higher. Actually $R_o=R_a+R(1+\mu)$.

This circuit is consequently of use only when the high value of R_o is not objectionable. The amount of feed-back is controlled by the value of R, but as this must be fixed by the grid bias needed some modification is often required. When R must be less than the value needed to provide bias, it can be made up to the required total by an additional series resistance which can be shunted by a large capacity condenser. When the bias resistance is not large enough, however, the arrangement of Fig. 1(b) can be adopted. Here C and R3 can be assigned arbitrary values of some 2 mfds. and 50,000 ohms while in the equations $R=R1+R2$. Only R1 is effective for producing grid bias, however.

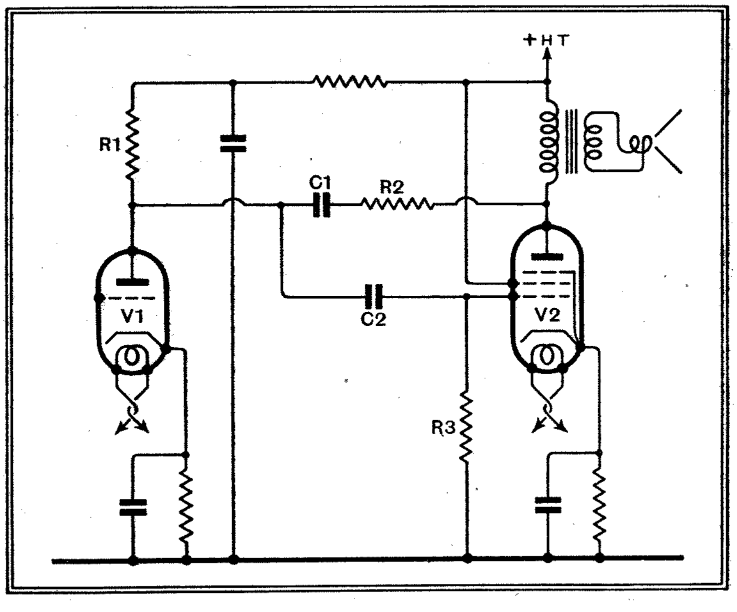


Fig. 2.—A feed-back circuit which has the advantage of greatly reducing the apparent AC resistance of the output valve. As explained in the text, this circuit is unsuitable for general use.

Another scheme which at first seems particularly attractive is shown in Fig. 2. The circuit is that of a normal resistance coupled stage except for the addition of C1 and R2. Actually C1 plays no part in the operation save that of insulating two points of different DC potential. It must, however, be large enough for its reactance to be negligible compared with the resistance of R2 at the lowest frequency required.

Circuit of Low Output Resistance

Actually, this resistance R2 forms a potentiometer across the output with the resistance of V1, R1, and R3 all in parallel. The proportion of the voltage developed across the output transformer which is fed back to the grid is $R/(R+R2)$ where R is the combined value of the resistances enumerated above. It is also easy to see that a rise in anode voltage causes a positive change in grid potential with the result that the effective AC resistance of the valve is lower than its normal value.

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A rise in anode voltage is a normal accompaniment of an initial grid voltage change in a negative direction, so that the feed-back is in the correct phase to oppose any voltage change applied to the grid, and to assist any voltage change due to the injection of voltage in the anode circuit. As a result, we can have the combination of negative feed-back with a low output resistance, which is just what we require.

Unfortunately, the circuit has one disadvantage, and it is one which is serious enough to prevent its use in practice. It is clear that as the anode and grid of the two valves are joined together through a condenser, they must be always at the same AC potential. Now the feed-back necessarily reduces the voltage changes on the grid of the output valve, and, consequently, it is clear that with this circuit it will also reduce the voltage changes on the anode of the preceding valve. This is equivalent to reducing the anode circuit load impedance of V1, and, in consequence, this valve may easily be overloaded.

Owing to this fault, the circuit is not one which can be recommended, and there would be no useful purpose in giving the design equations. It is sufficient to say that with the degree of feed-back necessary to give an output resistance of 1,000 ohms with a pentode and a distortion reduction to about one-fifth, the effective input resistance of the pentode is about 2,500 ohms only. The preceding valve can only give an undistorted output if it has a load resistance of at least 30,000 ohms. It cannot amplify without distortion if it has to work into a load of 2,000-3,000 ohms only.

A Practical System

A little thought soon shows the reason for the defects of the two arrangements which we have considered. The system of Fig. 1 has an infinite input impedance, or rather the normal input impedance of an amplifying stage, because the signal and feed-back voltages are introduced in series into the grid circuit, but it has a high output impedance because the valve and source of feed-back voltages are in series across the output transformer. Now with Fig. 2, the low input resistance is due to the signal and feed-back voltages being in parallel, while the low output resistance is due to the valve and source of feed-back voltages being in parallel.

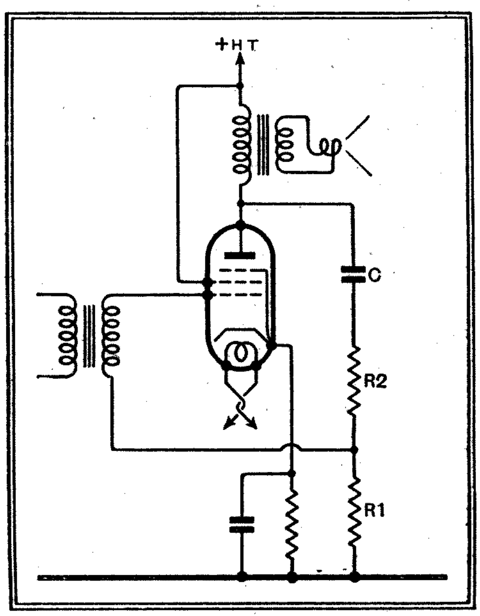

Fig. 3.—A practical circuit giving all the advantages of negative feed-back and a low output impedance.

It is thus clear that for the desired conditions of high input and low output resistance we must adopt the series input feed of the first circuit with the parallel output of the second. This can be done if we adopt transformer coupling to the output valve, and the circuit of Fig. 3 is free from the limitations of the earlier ones. The input resistance is that measured between the secondary terminals of the input transformer, and is obviously no different from that of any ordinary valve. For most purposes we can call it infinite.

The output impedance is the same as that of Fig. 2, when the resistances have appropriate values. Actually, $R_o = R_a/[1 + (R_a + \mu R_1)/(R_1 + R_2)]$.

The stage gain from the input transformer secondary to the output transformer primary is given by $A = gR''/[1 + gR'' R_1/(R_1 + R_2)]$ where g is the mutual conductance of the valve (A/V.) and $R'' = R'(R_1 + R_2)/(R' + R_1 + R_2)$ and $R' = R_a R_L/(R_a + R_L)$.

In design, we require most generally to start off by reducing the output resistance to a known level. The equation for output resistance is consequently best written in the form $R_2 = R_1\,[(1 + \mu + R_a/R_1 - R_a/R_o)/(R_a/R_o - 1)]$. In addition $R_1 + R_2$ must be much larger in value than R_L, otherwise some of the power output of the valve will be wasted in these resistances. The values of these resistances must not be higher than necessary, however, otherwise stray capacities will upset the performance at high audio frequencies.

Let us as an example take a concrete case of a Mazda Pen. 3520 valve. Under average conditions we may expect anode and screen voltages of about 185 volts, and the valve then requires a grid bias of 7.25 volts. The optimum load resistance is 4,400 ohms, and the normal output 2.45 watts for 4.5 per cent. second harmonic and 4 per cent. third harmonic distortion. The input is 5.8 volts peak, and the valve curves show R_a to be approximately 89,000 ohms with $g = 7.25$ mA/V. and $\mu = 650$.

In order to find R2 we have to decide on R_o and fix an arbitrary value for R1. We know from experience with triodes that a valve resistance of 1,000 ohms damps the loud speaker satisfactorily, so let us say $R_o = 1{,}000$ ohms and try $R_1 = 5{,}000$ ohms.

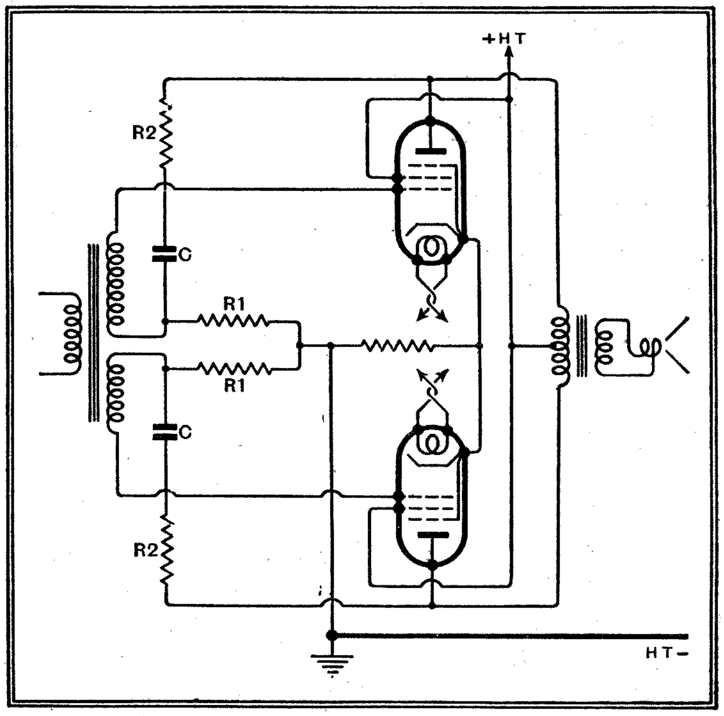

Fig. 4.—The circuit of Fig. 3 applied to a push-pull amplifier necessitates the use of an input transformer with a split-secondary. It is sometimes necessary to shunt the secondaries with high resistances to maintain an even frequency response.

We then have $R_2 = 5{,}000\,[(1 + 650 + 17.8 - 89)/(89 - 1)] = 33{,}000$ ohms. The nearest standard value is 30,000 ohms, and this will lead to a somewhat lower value of R_o and make $R_1 + R_2 = 35{,}000$ ohms, which is eight times the load resistance.

Now as to the stage gain; we have $R' = 4{,}190\Omega$ and $R'' = 3{,}740\ \Omega$, so that $A = 0.00725 \times 3740/[1 + 0.00725 \times 3740 \times 5{,}000/(5{,}000 + 30{,}000)] = 5.56$. Normally if feed-back were not used and R1 and R2 were absent the gain would be $gR' = 30.4$ times, so that the use of feed-back reduces the gain to 1/5.45 of its normal value. As the valve usually needs an input of 5.8 volts peak, it will now need $5.8 \times 5.45 = 31.6$ volts peak. This is about the value required by an average triode output valve, so that in effect the use of feed-back converts a pentode into a triode, for the stage has the same output impedance and requires the same input voltage.

Now as to distortion. An exact analysis is much more difficult than is the case when dealing merely with amplification, but the general effect is to reduce the distortion in the same ratio as the reduction of amplification. In this case, therefore, where we started with 4.5 per cent. second and 4 per cent. third harmonic and the reduction of gain is 1/5.45, we should expect with feed-back to obtain only 0.825 per cent. second and 0.735 per cent. third harmonic distortion. This is actually a

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lower distortion level than one would expect from a single triode.

It would seem that from a pentode with negative feed-back one can expect somewhat less distortion than with a triode when the conditions are adjusted so that both valves require the same input and give the same output. Both stages will have similar input and output impedances, but the triode stage will require more HT voltage. With two valves in push-pull, there should be less to choose between the two, and either system should give the same output with equally low distortion and require the same input. Again, however, the triode stage will need about 100 volts more for the total HT supply.

It is, of course, necessary to use an input transformer, and with push-pull a split secondary winding must be used as shown in Fig. 4. Practical experience indicates, moreover, that the transformer must have its secondaries shunted by resistances, otherwise a phase-shift occurs at high frequencies which leads to an excessive response around 10,000 c/s. With such a circuit, it should not be difficult to obtain a performance on the limited voltage of DC mains which is truly comparable to that which AC users have long enjoyed from a pair of triodes of the PX4 type, that is, a truly undistorted output of some 3-4 watts and good damping of the loud speaker.

In conclusion, it may be remarked that negative feed-back also reduces frequency distortion by rendering the gain less dependent on the anode circuit load impedance. It also lends itself to tone-control circuits of simple nature, provided that one does not object to some increase in amplitude distortion of the frequencies which are boosted.

It is clear, however, that the circuit is much less useful with triodes than with pentodes, for the gain of the former is already low, and cannot well be further reduced without leading to difficulties in the penultimate stage. At the present time the chief advantage of the arrangement is to give a pentode a performance which approaches that of a triode as regards quality of reproduction.

DISTANT RECEPTION NOTES

New Stations' Power Ratings

IT was announced some days ago that the new Rennes-Bretagne transmitter had taken over the full programme service from the old plant. So far, though, I have not found the voice of Rennes-Bretagne very loud, and I cannot believe that it is yet using its full 120 kilowatts. Certainly the volume obtainable is nothing like that from the 60-kilowatt Poste-Parisien or the 10-kilowatt Radio-Normandie. But then, Radio-Normandie has always appeared to use a very special brand of kilowatts. I doubt whether reception from Rennes will ever be very good, except at times when its neighbours are silent, for it is sandwiched between the 50-kilowatt Scottish National and the 100-kilowatt Königsberg, so that sideband splash is almost inevitable. There is a 10-kilocycle separation from the Scottish station, but one of only 9 kilocycles from Königsberg.

Elasticity of Output

Has anyone yet managed to log Klaipėda? This is a Lithuanian station, which started business in the early summer. It shares the wavelength of 531 metres with Athlone and Palermo; it is only at odd moments, therefore, that one may chance upon it working by itself. I have not managed to do so up to now, but I live in hopes. Given the right conditions Klaipėda should come in well, for it is rated at 10 kilowatts and the wavelength is favourable for long-range reception.

The new Deutschlandsender continues to be something of a mystery, and rumours are flying. It is said that though it may normally use 120-150 kilowatts, there will be very much more than that in hand for use if and when required. It is rather the fashion nowadays for new stations to be so designed and constructed that large increases in the output are very easily managed. The French Radio-National will have one of these "elastic" transmitters, and I believe that Toulouse P.T.T. could almost double the tale of its kilowatts in a very short space of time if the need arose.

The question of the limitation of power is likely to be raised at the next conference of European broadcasting authorities, and I should not be at all surprised if some of them press for a good deal more latitude. Under the present Lucerne plan long-wave stations may not exceed 150 kilowatts (though Moscow No. 1 is rated at 500). On the medium waves the maximum power originally allowed between 272.7 metres and 545 metres was 100 kilowatts, with special exceptions in favour of Budapest, Leipzig, Paris P.T.T., Prague, Rennes, Toulouse and Vienna, all of which were authorised to use 120. Rome No. 1 will shortly come into full service with 120 kilowatts, and the authorities in several other countries feel that the service areas of their big stations cannot be what they should so long as a limitation of 100 kilowatts is imposed.

RADIO-BELGRADE II.—A low-powered short-wave transmitter, adapted to the needs of broadcasting by the Government Press Department, and used for the transmissions of programmes intended for countries outside Yugoslavia.

For a country large in size, though not thickly populated, Finland is very well off in the matter of broadcasting stations. Most of us, I expect, have logged at one time or another its bigger stations on the long and medium waves. These are the 150-kilowatt Lahti on 1807 metres and the 10-kilowatt Helsinki on 335.2. But there are two other Finnish 10 kW stations, Oulu on 696 metres and Viipuri on 569.3, that have probably eluded us, since few sets nowadays will tune in the wavelengths between about 560 and 900 metres. On the medium waves there are some Finnish small fry, the pursuit of which should delight the D-X man who glories in logging difficult stations. Here they are: Pietarsaari, 0.25 kW, 200 m.; Turku, 0.5 kW, 209.9 m.; Vaasa, 0.5 kW, 211.3 m.; Tampere, 0.7 kW, 226.6 m.; Pori, 1 kW, 400.5 m.; Sortavala, 0.25 kW, 400.5 m.

D. EXER.

TELEVISION PROGRAMMES

The principal items only of each day's programmes are given. The system to be used each day is given below the date. Transmission times are from 3-4 and 9-10 p.m. daily.

Vision 6.67 m. Sound 7.23 m.

FRIDAY, NOVEMBER 6th.
(Baird.)

3.5, Silver Fox Breeding. **3.20**, British Movietone News. **3.35**, From the London Theatre—Sophie Stewart in scenes from "Marigold."

9.5, British Movietone News. **9.15**, Boxing Training demonstrated by members of the Alexandra Amateur Boxing Club. **9.40**, Film, "Television Comes to London."

SATURDAY, NOVEMBER 7th.
(Baird.)

3.5, Zoo Animals introduced by David Seth-Smith. **3.20**, British Movietone News. **3.35**, Cabaret.

9.5, Pictures and Sculpture from Forthcoming Exhibitions. **9.20**, British Movietone News. **9.35**, Cabaret.

MONDAY, NOVEMBER 9th.
(Marconi-E.M.I.)

3.5, The Mobile Post Office. **3.20**, British Movietone News. **3.35**, Picture Page.

9.5, Film, "Television Comes to London," **9.25**, Picture Page. **9.50**, British Movietone News.

TUESDAY, NOVEMBER 10th.
(Marconi-E.M.I.)

3.5, Performing Alsatians. **3.25**, Major Faudel Phillips demonstrating Show Pony Jumping. **3.40**, British Movietone News. **3.50**, Lisa Minghetti (violin).

9.5, British Movietone News. **9.20**, Pageant Reconstructing Lord Mayor's Show. **9.50**, Movietone Magic Carpets: Giants of the Jungle.

WEDNESDAY, NOVEMBER 11th.
(Marconi-E.M.I.)

3.5, Armistice Programme: A Document of War and Peace. **3.20**, British Movietone News. **3.35**, The Vic-Wells Company in "Job."

9-10, Repeat of afternoon programme.

THURSDAY, NOVEMBER 12th.
(Marconi-E.M.I.)

3.5, London Characters: "Josh" Cairns (the busker) and ex-Pipe Major Massie (from Trafalgar Square). **3.20**, British Movietone News. **3.35**, Championship exhibits from the International Poultry Show. **3.50**, Movietone Magic Carpets: Giants of the Jungle.

9.5, Repetition of 3.5 and 3.20 programmes. **9.35**, Ballroom Dancing—Demonstration of steps.

Beautiful Baffles !

SYMMETRICAL SHAPES FOR UNIFORM SPEAKER RESPONSE

By D. W. ASHWORTH

To reduce and distribute interference effects due to a baffle it is necessary to have as wide a variation as possible of the shortest path between back and front of the diaphragm. The author shows that the satisfaction of this condition need not result in a baffle of ugly appearance.

It often happens that a thing designed for utility alone is not good to look upon. Yet if we consider the *Queen Mary* or a 'plane like the one which won the air race from London to Melbourne we see that this is not always the case. The writer hopes to show that the principle which led to the design of the irregular loud speaker[1] baffle, if carried to its logical end, leads to a shape which, if not passable as "beautiful" to a critical artistic eye, is at least much nearer to that ideal than its predecessor.

In the recent article, which described the irregular baffle which has been developed to eliminate irregularities of response found with conventional square baffles, it was pointed out that the worst shape is a circle concentric with the speaker cone. With such a baffle the length of the path of the sound waves from the front of the cone to the back is the same, in whichever direction it is measured. In other words, all paths are the same in length. Therefore, the inevitable reinforcement and weakening frequencies of all paths are the same, and add together to cause marked irregularities in the response curve. Fig. 1 (a) shows the fundamental or first pair in the series of such irregularities, as one would expect them to appear in the otherwise smooth curve of a speaker in a baffle whose diameter is 13 inches greater than that of the cone. Note that they are concentrated in narrow bands of frequency.

In a conventional square baffle the sides are tangents to a circle which is almost invariably concentric with the cone. The centre portions of the sides therefore constitute a considerable portion of baffle edge providing paths of about the same length and resonating at about the same frequency. But some of the edge near the corners is at greater distances from the cone, so the irregularities in the curve are spread out towards lower frequencies as shown in Fig. 1 (b). Note that there are four portions of the edge of this baffle at one distance from the cone, but the curve is not so bad as the one in Fig. 1 (a) where there is only one such portion. Of course, what counts is not the number of such portions but the angle they subtend at the centre of the cone.

The *Wireless World* baffle places the four sides at four different distances, so that there are four sets of irregularities in the curve, but as there is only a quarter of the angle subtended at each distance, each irregularity is of only a quarter the intensity. Moreover, two of the fundamental dips in the curve occur at nearly the same frequencies as two of the fundamental humps, so that they partly cancel out as in Fig. 1 (c).

Now, to carry the process to its logical conclusion let us have, not four quarter-size humps or even twenty twentieth-size humps, but a slight increase in response spread *evenly* over a range of frequencies. By this means the reinforcement or weakening at any frequency is kept small, and the curve is made smoother. The greater the range of frequencies chosen the smaller the modification of the ideal curve; so the distance of the baffle edge from the cone should be spread between limits as widely separated as possible. The lower limit will affect the bass cut-off, so it cannot be made too small; and the upper limit will be determined by the allowable size of the baffle. The shape should be the one which distributes the baffle edge (as measured by the angle it subtends at the centre of the cone) most uniformly between the chosen limits, that is, the common spiral. All the portions of such a baffle between d in. and, say, (d + 1) in. from the cone, added together, subtend the same total angle at the centre, whatever d may be.

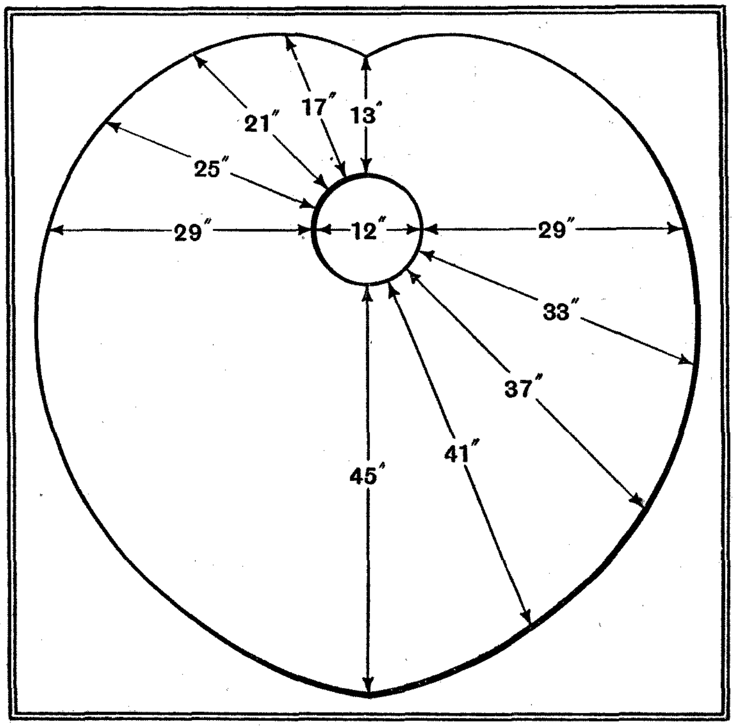


Fig. 2. Suggested heart-shaped baffle developed from two common spirals.

If the spiral runs from a minimum of 13in. from the cone out to a maximum of 45in., the fundamental reinforcement is spread from 75 c.p.s. to 260 c.p.s., and the fundamental dip from 150 c.p.s. to 520 c.p.s. Between 150 c.p.s. and 260 c.p.s. the two cancel as shown in Fig. 1 (d).

The baffle may be bounded by two spirals of opposite hand to form the heart shape of Fig. 2, which is equally effective, and which many people will regard as superior in appearance to the rectangular forms.

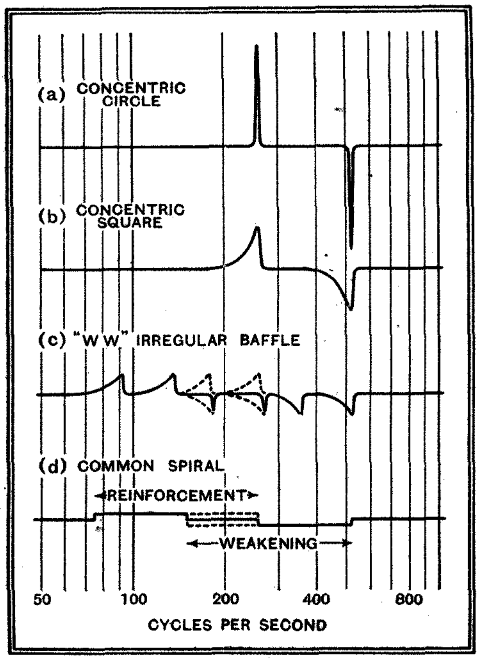


Fig. 1. Diagrammatic response curves showing the interference effects in baffles of various shapes. For simplicity the bass cut-off has been ignored.

[1] *The Wireless World*, May 22nd, 1936.

New York Radio Show

By Our New York Correspondent

The Zenith Zephyr 10-valve all-wave receiver, seen in appropriate surroundings

DISAPPEARANCE OF THE COMPONENT

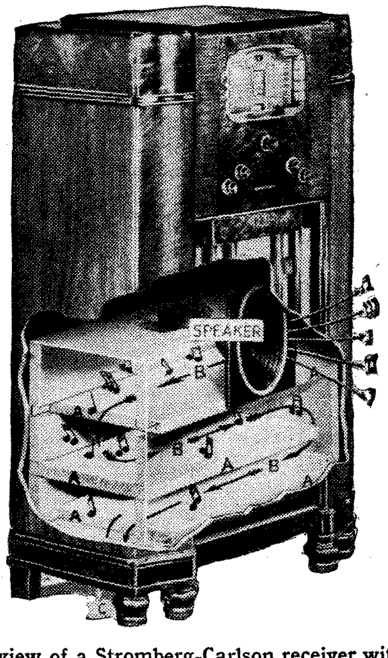
▽

LACK OF TECHNICAL INFORMATION

THE retail radio season was ushered in on September 9th, when the National Radio and Electrical Exposition opened at Grand Central Palace for its ten-day showing. Its purpose was to tell the advance story of radio and to feature in addition lighting, refrigeration, heating ranges, air-conditioning, oil burners, laundry equipment and other domestic and industrial appliances.

To the radio fan there was little reminiscent of the shows of five to ten years ago, which were largely devoted to exhibits by parts manufacturers for the set builder. This year not a part could be found, and little technical information.

To the writer, the 1936 "show" struck a new low level from the point of view of interest—although there were four fine exhibits of receiver manufacturers, and several miscellaneous electrical and radio exhibits of interest.



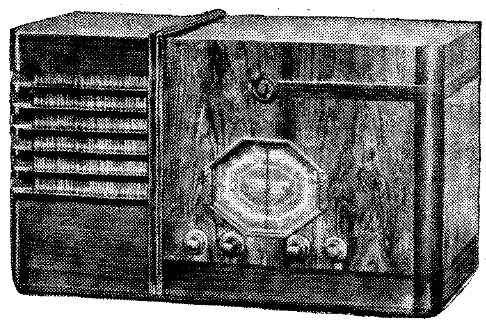
A view of a Stromberg-Carlson receiver with the cabinet cut away to show the acoustic labyrinth

Stromberg-Carlson had an outstanding booth, from both an artistic and radio viewpoint. In addition to their complete line of receivers and radio-gramophones, they displayed many interesting features of their receivers, such as the "Acoustic Labyrinth" in cross section; their single and dual high-fidelity speakers, with particular emphasis paid to their new Carpinchoe leather surround on all of their better single-unit and low-frequency speakers. As usual, their chassis were gems of construction and design. Their exhibit also included a 20ft. square demonstration booth—soundproof and furnished in the style of an average living room. This, strange as it may seem, was the *only* place in the entire show where it was possible to listen to a receiver in operation; and although we passed this demonstration booth of Stromberg-Carlson several times we failed to see anyone putting the receivers through their paces. This may have been a coincidence, as our visits were all made in the afternoon, when the visitors to the show were at a minimum. Perhaps the evening told a different story. Also, in their demonstration room Stromberg had one of their high-fidelity radio-gramophones (with automatic record changer) equipped with the only remote control in the show. This control can select any station, and is equipped with a remote tuning meter for correct tuning, or it can be used to bring in one of a dozen preselected stations. In addition, the volume is controlled by a second motor. Other functions performed at a distance are the selection of loud speakers—if the house is equipped with several—and the operation of the phonograph. Once it has been loaded with records, it may be started and stopped, and records may be rejected from the distant point.

Next of interest was the General Electric exhibit. This featured their new Colorama Dial, which automatically flashes from red to green when the receiver is tuned to resonance, and in connection with the G-E automatic frequency control (similar to R.C.A.'s development, which R.C.A., strangely, are not using in their own receivers) should ensure perfect tuning, even by the careless layman. Other features are the local station personaliser, one of the few arrangements in America whereby the station letters are flashed as you tune in; G-E. silent tuning, which is a simple switch operated by the tuning knob so that the receiver is silenced while a hand is grasping the knob, and operates normally once the knob is released; sentry box, which is a cleverly designed RF tuning unit; G-E. sliding rule tuning scale, which lists all stations in a straight horizontal line, using an entirely separate scale for each band; and the G-E. stabilised loud speaker, in which the magnetic structure, pole piece, etc., are keyed into place and welded, thus stabilising the structure magnetically and mechanically.

Zenith also had an interesting exhibit which featured their very attractive and readable 10in. to 12in. dials and their acoustic adapter, a bell-shaped device which could be moved over the back of the low-frequency speaker to control its low-frequency resonance—adapting its frequency response to rooms of different size. Inspection of their chassis also showed the explanation of the fast, smooth action—almost effortless—of their tuning mechanism. On the shaft with the tuning knob was a sizable flywheel, which seemed to remove the usual laborious dial twisting. Several of the Zenith receivers featured multiple speakers—their Stratosphere was equipped with two 12in. speakers and one moving-coil tweeter of the diaphragm type. Others employed a single low-frequency speaker in conjunction with a direct radiator cone type of tweeter.

R.C.A.'s exhibit featured their Magic Voice, record reproduction, service oscillators and the cathode ray tube.



Stromberg-Carlson three-band receiver

Sparton (Sparks-Withington) were one of the few exhibitors who featured volume expansion. Their representative stated that expansion, with its increased volume, range and reduced background was of great

New York Radio Show—
value when demonstrating receivers—either to dealers or to the public. Their large and attractive dials of clear glass with band scales and figures in harmonious tints were of interest.

Crosley showed for the first time their new 37 tube receiver—a high fidelity model equipped with Jensen's super efficient 18in. low-frequency speaker (Woofer), two middle frequency reproducers and three of the finest exponential horn-moving coil tweeters. As might be imagined, volume expansion was included in this $1,500 masterpiece. Four chassis are used—the tuner, audio-frequency amplifier, power supply and a separate power supply for the six speaker fields. The three speaker systems were each fed from a separate audio-frequency channel, each channel having panel gain controls so that the balance could be adjusted to suit the user.

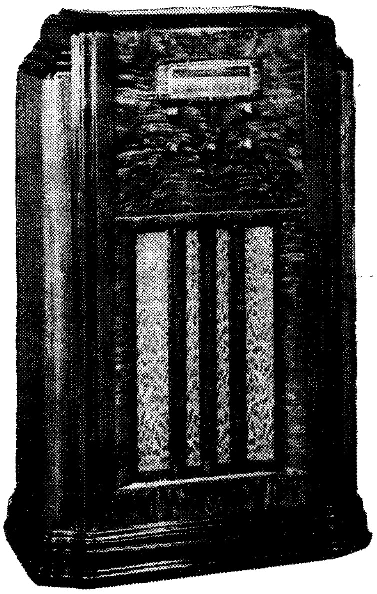
The Output Stage

Fairbanks-Morse stressed their "Turret Shield," an overall shield to prevent the pick-up of man-made static by the radio-frequency circuits. In the centre of their exhibit was a shielded booth with signal generator, output meters and several chassis —with and without the Turret Shield. Unfortunately, no one connected with their exhibit had the slightest idea of the purpose of the shielded booth and equipment.

Emerson and Fada displayed many attractive receivers, the former concentrating on the small personal receiver.

Neither Philco nor Grunow, with their telephone dial type of tuning were on show.

The return of the triode output tube in large numbers, almost always in push-pull, is certainly a significant step. Not forwards,



A General Electric receiver of the all-wave type

perhaps, as we were using many such output stages in 1928-29, but at least in the right direction!

Of possible interest is the fact that many receivers employing our new "Beam Power" tube employ split-load inversion, which has been endorsed by Mr. W. T. Cocking in *The Wireless World*, so that 10-15 watts of good quality output can be secured from a resistance coupled p-p amplifier at fairly low cost. This is largely due to the power sensitivity of these tubes.

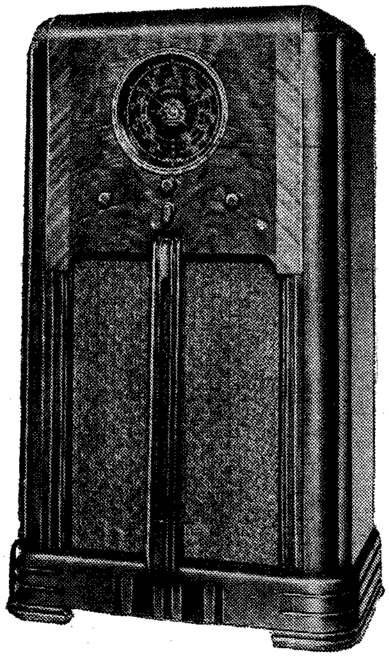
It would seem that the trend of this year's receivers is toward separate radio-frequency assemblies of the type employed in the "W.W." All-wave Super Seven. Also, many manufacturers are going to overall or box shields entirely enclosing the radio-frequency circuits. Next in importance would seem the use of much better loud speakers by most manufacturers. Although a few flimsy units could still be found, most of the medium-priced receivers employed well-built speakers, with ample fields. This is partly due to the increase of power available.

As in England, the all-wave receiver has swept the country by storm. In fact, it would appear to be impossible to secure a broadcast band receiver with the exception of a few $10 to $15 models. Strange as it may seem, we seldom run across anyone who enjoys short-wave reception, the majority leave their receivers on the broadcast band, and, in fact, spend 95 per cent. of their time listening to three or four local stations (in and around New York). To the writer this would seem to indicate a market for a pre-tuned switch or button-controlled local receiver. However, none of our manu-

The RCA-Victor receivers include a cathode-ray tuning indicator

facturers has had the courage to produce such a model. Also, some form of remote control would seem highly desirable, so that the receiver could be tuned, volume adjusted, etc., at a distance from the speaker, where listening at moderate level is most enjoyable; but with radio used as a continuous background, operated so softly in many cases that it is difficult to tell whether it is on or off, such measures are probably unnecessary.

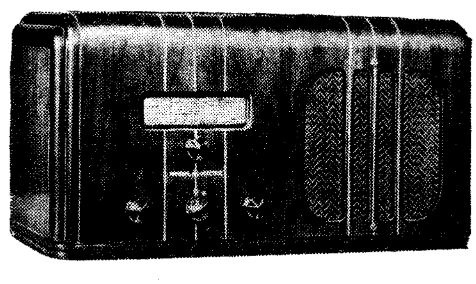
Although several manufacturers are featuring the new "Beam Power" tubes in circuits designed to deliver from 10 to 60 watts, others are using medium power triodes and pentodes in class A or AB. Variable selectivity is also included by the majority—even in their low- to medium-priced merchandise. The above changes should certainly note a trend toward better fidelity, if not "high" fidelity. In connection with high fidelity, it would appear as though the American dealer is the weak link in the chain between manufacturer and the public, including the broadcaster. The dealer apparently knows nothing and cares little about such matters, and is in no position to point out to his customers the greatly heightened pleasure which might be experienced from listening to our fine programmes when reproduced by a truly high fidelity receiver. Many of our receivers which are advertised as "high fidelity" do not give a very pleasing impression when operated in the "high fidelity" position. In several cases known to the writer the electrical or chassis fidelity is nearly perfect, so that it is logical to expect that the high



Crosley 7-valve 3-band receiver with a 6-watt output stage

frequency response of many so-called high fidelity speakers is very rough or peaked. This gives the "high fidelity" a black eye, and it is the writer's hope that the high frequencies which distinguish the high fidelity receiver from the average "radio" may be made smoother and more pleasing in the near future, so that everyone will enjoy and consider the high fidelity reproduction to be more "natural" rather than shrill or harsh as so many do at present.

Tuning to resonance of this year's receivers should be simpler than ever before. Four or five of our largest manufacturers have adopted automatic frequency control, which eliminates the necessity for careful tuning. However, there is some feeling that is not the final answer for high-fidelity reception, as cross modulation becomes a much more serious problem when AFC is used in conjunction with receivers operating with wide-band selectivity. Noise may be



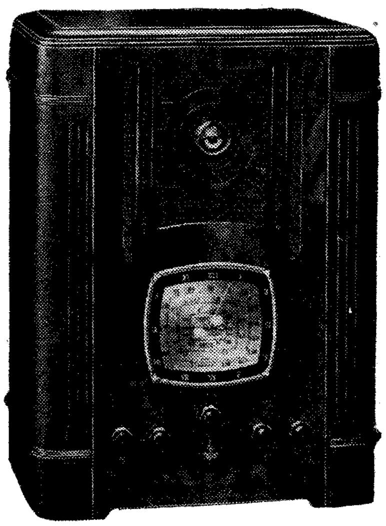
A table model receiver It is the General Electric E-72 with seven valves

another consideration, as with the high-frequency stages detuned by nearly 10 k/c, noise will be greater and quality distinctly poorer than when properly tuned.

New York Radio Show—

Resonance indicators are being used on more receivers than heretofore. Almost all medium-priced receivers have some sort of indicator; the "Magic Eye" or cathode-ray tube is finding general favour, although meters and shadow tuning are still used by a number of manufacturers. Many of these devices (Magic Eyes, too) are operated from sharply tuned circuits tuned exactly to the intermediate frequency, so that indication is accurate regardless of the setting of the fidelity control. There seems to be room for improvement here, however, as it is still impossible to tune many receivers properly, when their IF band-width is a maximum. As the public is reluctant to learn any routine such as a method of tuning by adjusting the selectivity to a maximum, tuning to resonance and then expanding the band-width each time a shift is made (which with our many local stations in a number of the larger cities means frequent tuning, sometimes at fifteen-minute intervals), they will either content themselves with leaving the receiver adjusted for maximum selectivity (minimum fidelity) or will not be tuned to resonance much of the time.

Metal tubes are a selling point, admit most of the receiver manufacturers, but no more vital than dial design or other features of a similar nature. A few of the more radical buyers demand them, but the majority accept a receiver which suits their artistic, financial or musical taste, whether it uses metal tubes or not. Last year's



The Emerson M-140 12-valve AC/DC receiver covering 16-2,000 metres

failures with defective tubes have also reacted against them in the eyes of many. As an example, Sparton in most of their models employ but two metal tubes, the high-frequency amplifier and first detector or mixer; the others all being glass. Many receivers are equipped with the octal base, and are sold with either metal or glass tubes, according to the preferences of the individual customer.

Dials and tuning mechanisms are much easier to operate than formerly, and the dials have been greatly improved in appearance. Many of this year's receivers employ two-speed tuning with but a single knob. This is so worked out that, while tuning in one direction, the condenser is rotated at high speed, but as soon as the direction is reversed a clutch operates, allowing the tuning-in to be completed at slow speed.

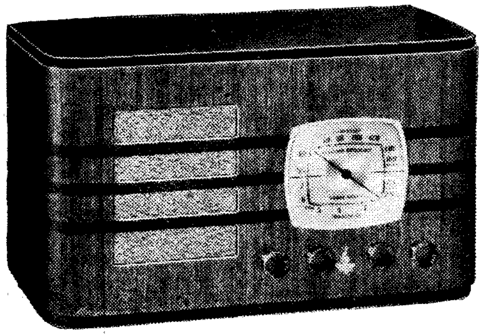
Many dials also have ports or openings in which appear frequency-band designations, selectivity or fidelity settings, and perhaps an indication of the tone-control setting. There is still a division of practice between many frequency scales on one dial, with its attendant confusion, and the newer and more complicated practice of exposing only one scale at a time. Whereas the latter is much more expensive (many ingenious schemes for this are in use), its use would seem destined to grow because of the simplicity of operation.

Cabinets are improving both in finish and construction, although there were very few on display which the writer would care to have in his home. The end table vogue seems to be spreading, and in this connection there were a number that combined modernistic lines with simplicity and ease of operation.

Six-volt accumulator operation of receivers for farm use is developing rapidly. In most of these receivers, vibrator high-tension supply is used. The majority of these receivers are intended to be sold with wind-chargers (generators operated by the wind through a windmill or propeller), thus reducing the operating cost to a negligible figure. For those living in localities where the average wind speed is insufficient to keep a battery charged, a number of inexpensive compact gas-engine-driven generators have recently made their appearance. In general, these units, consisting of single-cylinder engines with electric starters coupled to generators of 150 watts at six volts, sell for approximately $45. Others can be obtained delivering up to 1 kW or more, DC or AC, at proportionally greater cost. These should also increase the use of appliances and electric light in the farm home.

To depart from the radio receivers, there were two studios from which a number of broadcasts originated. As these studios were provided with glass walls a large crowd could always be found with noses pressed to windows, fascinated by the ever-mystifying process of broadcasting.

The New York Police department had a very interesting display consisting of police transmitters and receivers, traffic-signalling systems, etc. An officer was present who explained the manner of despatching police cars, and their *modus operandi*. The New York Y.M.C.A. also had a fascinating display of photo-cell devices such as speed traps for the catching of speeding motor cars, infra-red and capacity-operated burglar alarm systems. These latter devices puzzled the crowds, who continuously attempted to creep up on a very shiny watch which was offered to anyone who could touch it without ringing the bell. However, they were all forced to depart baffled. An



The Emerson L-122 is a 5-valve set covering 40-136 and 172-555 metres

electronic organ was among the exhibits, and was played upon by one of our leading cinema-organ virtuosi. This same gentleman attempted to explain its operation, attack, wave form, and other phenomena, but, unfortunately, was not making much progress at last report.

One other phase of possible interest was the number of car radios shown. Nearly all of the exhibitors included one or more such models, but, so far as we were able to learn, there was little interest displayed in these. It is possible that the car radio has been so widely accepted that little of former novelty remains.

In conclusion, it would seem that Mr. Hartley's "Whither Exhibitions?" is just as applicable in America as in England. Even more so, on second thought, as no provision has been made in several years for any sort of demonstration, although it is possible for the exhibitor to secure a demonstration room for a large increase in booth rental. It would seem to the writer that the "Radio Show" should provide the opportunity to educate the public toward the final peak of "natural" reproduction, instead of the carnival side shows of to-day!

Records for Testing and Demonstration

New H.M.V. Album of Five Special Discs

IN the record No. DB4033 reviewed in our issue of April 10th, 1936, H.M.V. have already provided a very useful source for the demonstration of pitch, amplitude, beats, harmonics, etc. This record is now available with four others in an album (No. 252), priced 34s. The four new records (DB4034 to DB4037) provide a series of 57 constant tones, ranging in frequency from 25 to 8,500 cycles. A calibration table is given showing the corrections to be applied below 250 cycles, and the maximum error on the outside grooves is within ±0.25 db.

The second side of the last record gives a gliding tone from 8,500 to 25 cycles, and a groove indicator is provided showing the frequency in relation to the position of the playing needle. Space is left on the indicator strip for pencil notes during the course of playing. The markings can be erased if desired.

There are innumerable applications for records of this type, and the instruction leaflet gives particulars of experiments to demonstrate pick-up tests, Chladni dust figures, the formation of nodes in Kundt's tube, and room reverberation tests.

New Technical Service

WITH the co-operation of a number of dealers throughout the country, the Mullard Wireless Service Company has instituted a new scheme whereby home constructors are encouraged to make the fullest possible use of the Mullard Technical Service Department. These special dealers will give help in solving any problem relating to home-constructed receivers, particularly in regard to valves; where the required information cannot be supplied on the spot, the query will be dealt with promptly from headquarters.

Broadcast Brevities

NEWS FROM PORTLAND PLACE

The Continent Listens

A BELGIAN visitor to Broadcasting House last week, asked whether he had heard the inaugural broadcast of the new concert organ in St. George's Hall, burst out laughing. The question, it seemed, was ridiculous.

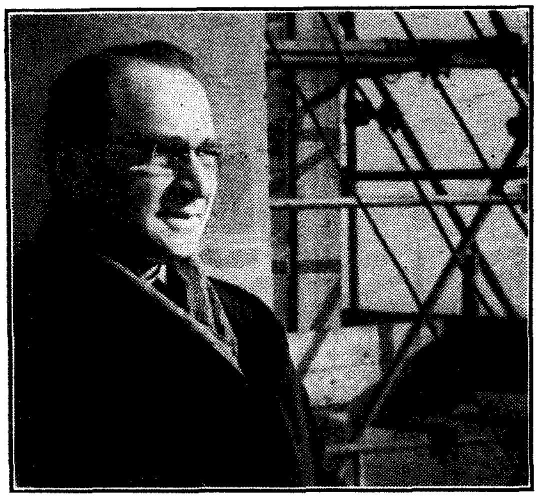
Of course he had heard the organ. All Belgium, all the Continent, had been listening. And why?

Where Britain Leads

Strange though it may appear to our modest ears, Europe as a whole seems to put British cinema organs and organists in the front rank. The few organs of this type on the Continent lack the versatility of the British instruments and are rarely played with the same brilliance of execution—and the same applies to dance bands.

Jazz band leaders over there listen attentively to the British dance music broadcasts, modelling their own methods on those of the acknowledged leaders in this country. Hence there is the Henry Hall style, the Jack Payne style, and half a dozen others.

It is doubtful, though, whether the Continent as a whole studies the other B.B.C. broadcasts with the same assiduity.



"Television comes to London." — Dr. Zworykin, the iconoscopic inventor, in a "still" from the film first transmitted last Monday, and . . .

Broadcast from a Motor Factory

NEARLY a hundred employees in a Midland motor factory have speaking parts in a broadcast feature programme which Robin Whitworth is producing towards the end of November. The broadcast will give a vivid sound picture of how cars of to-day are turned out by mass-production methods. The Mobile Recording Unit is already at work in the factory.

A Leg-pull ?

EIGHT bars of music manuscript, beautifully written, reached the B.B.C. Music Department from a French newspaper last week. With it was a letter of enquiry.

"Is it," asked the writer, "a Welsh, Scottish or Irish national air that the British broadcasting stations are using as their interval signal? I enclose a transcript of the tune as we hear it on our receivers."

The tune was "Ol' Man River."

"Interest" Features in Television

IN Wardour Street an "interest film" is any strip of celluloid which successfully avoids news, love, or adventure —a somewhat rare feat. What exactly constitutes an "interest" feature in television must be left for individual televiewers to decide, but there is no doubt that the producers at Alexandra Palace are anxious that those sections of the programmes coming under this description shall really merit the term.

Demonstrating Anti-Aircraft Guns

One of the most promising is the first television gardening demonstration which Mr. C. H. Middleton, of sound broadcasting fame, is to give on November 21st. Mr. Middleton will offer illustrated hints on Autumn Pruning in the Baird spotlight studio. Historical inn signs through the ages will be shown and described by a student of the subject on November 17th.

Two big shows to be expected during the M.-E.M.I. week, November 23rd to 28th, are a fencing lesson by women champions and an anti-aircraft gun display in Alexandra Park.

A Freak Report

THE report that a Johannesburg amateur has been picking up the television transmissions—more than 4,000 miles away—is regarded with the greatest equanimity by the B.B.C. engineers.

That the thing may have been done is not disputed, for reports of freak reception from odd corners of the world have been expected ever since the transmissions began. As contributions to the strange history of ultra-short-wave work such reports are interesting; but their true significance cannot yet be determined.

What Did He Hear ?

Meanwhile, confirmation of the Johannesburg feat is lacking; the only programme item to which the distant listener draws attention, viz., a tour of Southampton docks, has never featured in a transmission from Alexandra Palace.

And yet, if he was not hearing London, what *was* he picking up?

A tantalising question.

Seeing and Hearing "Pickwick"

TELEVISION is to provide the world *première* of "Pickwick," Albert Coates' new opera at Covent Garden, excerpts being presented in the Alexandra Palace studios on November 13th; but for most set owners the first radio performance will be on November 30th, when Act I of "Pickwick" will be relayed from the Opera House in the Regional programme. The scenes to be depicted are "The Pickwickians at the Manœuvres"; "Manor Farm, Dingley Dell"; "Jingle's Intrigue," and "The Inn and Sam Weller."

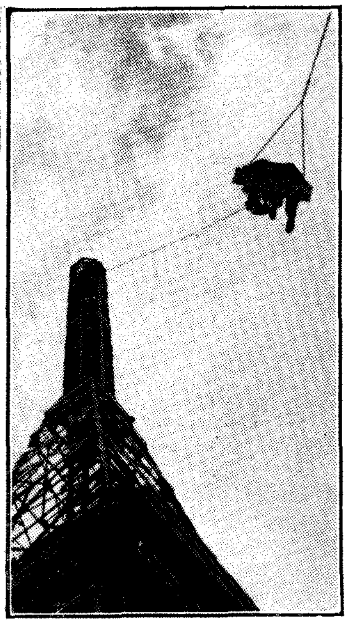
The Players

The part of the immortal Pickwick falls to that fine singer, William Parsons. Stanley Pope plays Snodgrass and Dennis Noble appears as Sam Weller. Aunt Rachel is played by Enid Cruickshank.

Acoustic Tests at Sadler's Wells

ONE of the pleasant reminders that winter broadcasting is back in full swing is the renewal of the operatic relays from Sadler's Wells.

The "O.B." engineers take a lot of care over these broadcasts, and have conducted some interesting experiments in order to obtain the best possible acoustic effects. It is generally realised that orchestra pits in theatres are not ideally placed from a broadcasting point of view, there being a tendency for the stage singers and chorus to overwhelm the instruments, or vice versa, depending upon the position of the microphones.



. . . the camera-man, working under difficulties, makes an impressive "shot" of the Alexandra Palace aerials, during the making of the film.

"Stereophonic" Effects

In the case of the Sadler's Wells broadcasts, the engineers have hit upon a happy solution. The output from the orchestra "mike" is conveyed to a loud-speaker in the Concert Hall at Broadcasting House, where it is picked up by another "mike" to be "mixed in" with the output from the stage. In this way additional resonances are introduced and an almost "stereophonic" effect is obtained.

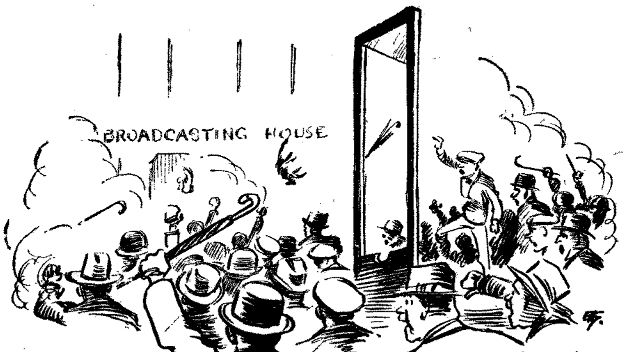
Airmen in a Variety Bill

AN imaginary aerodrome "somewhere in France" will be the scene of a novel variety programme on November 25th, in which all the artists will be men who have actually served in the Royal Air Force, the Royal Flying Corps, or the Royal Naval Air Service.

The "bill" includes Hugh Wakefield, the stage and film star (who "finished up" as a Wing Commander), Laddie Cliff, Roy Royston (who won the M.C.), G. H. Elliott, the coloured singer, Jack Warman, and many others. Alan Russell and Charles Brewer, who also appear, were Wing Commanders in the R.A.F. The occasion will be a "dud night," when stormy weather makes flying impossible, and the men get together for a rousing "singsong."

UNBIASED

By
FREE GRID



Armed revolt of listeners

The B.B.C.'s Own Scrap Book

I SUPPOSE that a great many of you have been busy of late furtively inserting a knife into the slot of the children's money-box in order to obtain the necessary cash to purchase a television receiver? Undoubtedly the stuff which is coming over is remarkably clear and well-defined considering the relatively short time that television has been an accomplished fact, but this is not, of course, by any means the same thing as saying that it is without blemish.

I think, however, that it is fully as good as were the B.B.C.'s earliest efforts at sound broadcasting way back in 1922, but there is little doubt that ten years hence we shall all raise a laugh at what we shall regard as the crude efforts of 1936 just as nowadays, when we think back to the days of Marconi House, or even of Savoy Hill, we wonder how we put up with the terrible lack of quality associated with the early sound transmissions. I do hope that the B.B.C. will have the sense to stand a cinema camera in front of a television viewing screen and make a permanent record of a typical programme of to-day, so that a decade hence they can stick the film on the air and show us what tremendous advances, both technical and artistic, will have been brought about since the film was made.

It is, I think, a tremendous pity that nobody thought of making gramophone records of the earliest B.B.C. sound programmes, since they would be both amusing and instructive nowadays and serve to silence those critics who believe that no great technical advances in the matter of quality of transmissions have been made during the time that broadcasting has been with us. There is, however, one thing which the B.B.C. might do as a change to the various scrap books which are served up to us from time to time, and that is to re-create for us some of the programmes of the very early days of broadcasting, thus giving us a scrap book of their own.

They surely must have in their archives full details of the items and artistes associated with the earliest concerts, and in any case they could find them in their file copies of the Radio Times. They could in all probability get together a large proportion of the original artistes, and failing that they could obtain help from some of the ancient gramophone discs preserved in the libraries of the big recording companies or, at the worst, they could provide suitable substitutes.

There is only one snag which would prevent the B.B.C. from adopting my suggestion and putting one of their old-time concerts on for us, and that is that the comparison between the bright and breezy programmes of those early days and the efforts of 1936 would be so striking that it would lead to an armed revolt of listeners.

"There Are More Things in Heaven and Earth . . ."

AS most of you know I have from time to time been compelled to say a few unkind things concerning wireless manufacturers and their playful little ways, but I must confess that, as a result of a conversation I had the other day with one of them, it was brought home to me that, when all is said and done, their life is not entirely a bed of roses and they have their trials and troubles like human beings.

The particular annoyance which this manufacturer was telling me about was the trouble there was to gauge accurately the public demand for the various gadgets which are associated with the design of a set. Sometimes, it appears, a certain style of tuning dial will, for some obscure psychological reason, become all the rage, and sets not possessing it degenerate into an absolute drug on the market. At other times some patent tuning indicator which has been in strong demand seems to lose all popularity and becomes useless as a selling point.

The most recent example of the apparent fickleness of the public taste is of such a striking and unusual nature that at first I frankly declined to credit it when my manufacturer friend related it to me, and had not he given practical proof of the truth of his words I should still have been an unbeliever. It appears that for some considerable time past there has been a growing demand for the supply of sets without their cabinets. At first it was not unnaturally supposed that this was an indication that the public were thoroughly fed-up with the design of existing cabinets and were purchasing the chassis alone so that they could put them into cabinets of their own choosing.

As a result of this the cabinet-designing department wallahs were sacked *en bloc* and a new lot engaged, but to the great surprise of everybody this did not have the desired effect. The next move was to farm out the design of the cabinets to world-famous artists and furniture designers, but this, if anything, made matters worse. Eventually it was discovered that several other set makers were in a similar predicament, and they also had not improved matters by engaging highly paid specialists.

At an emergency conference of these manufacturers it was decided to call in the help of an American firm of business efficiency experts which apparently exists for the purpose of finding out who has had the money when a firm goes bust and for doing similar kinds of detective work. The money paid out in paying the rather high fees to this firm proved to be very well spent, however, since they soon had the solution of the mystery all cut and dried. It appeared that the increasing demand for sets without cabinets had been due to the growing popularity of broadcast listening among colonies of what I may term super-nudists which are springing up in certain parts of the country. I use the term super-nudists advisedly, for it seems that there are certain followers of the nudist cult who carry their ideas to such extremes that even their possessions must, where possible, be bereft of their outer covering, and, of course, one of the first articles to suffer was the wireless set.

A well-known psychologist who was consulted on the matter explained that, except that it was 180 degrees out of phase, the idea was similar to the early-


180 degrees out of phase.

Victorian fashion for concealment of the nether limbs which certain of the more fanatical of our grandparents carried to extremes by extending to the legs of chairs and pianos, etc., which used to be encased in frilly pantaloons. If, therefore, in future, any of you dealers are asked to sell a chassis only, you will, no doubt, look upon your customer with renewed interest.

The Radio Tourist

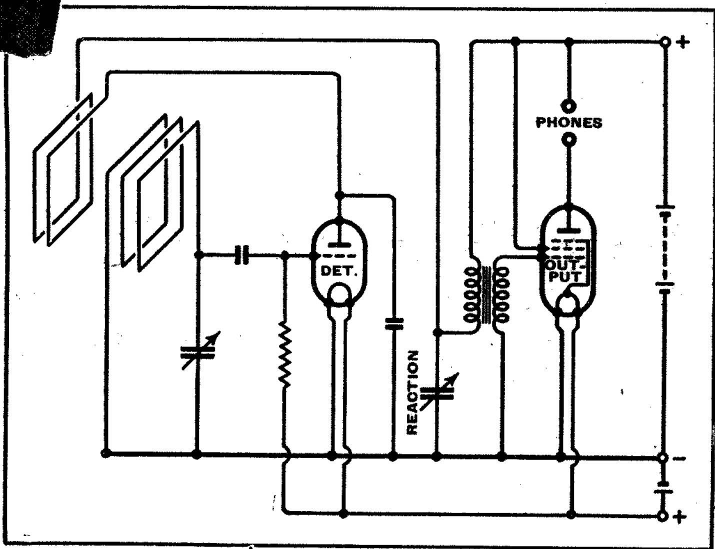
A DIMINUTIVE BUT VERY PRACTICAL PORTABLE

FEATURES.—***Type.***—*Portable battery receiver for use with headphones.* ***Circuit.***—*Triode detector (with reaction)—pentode output valve.* ***Controls.***—*(1) Tuning. (2) Volume (reaction). (3) On-off switch.* ***Price*** *(with valves and batteries, but excluding 'phones), £3 17s. 6d.* ***Makers.***—*Transreceivers Ltd., 444, Ewell Road, Surbiton, Surrey*

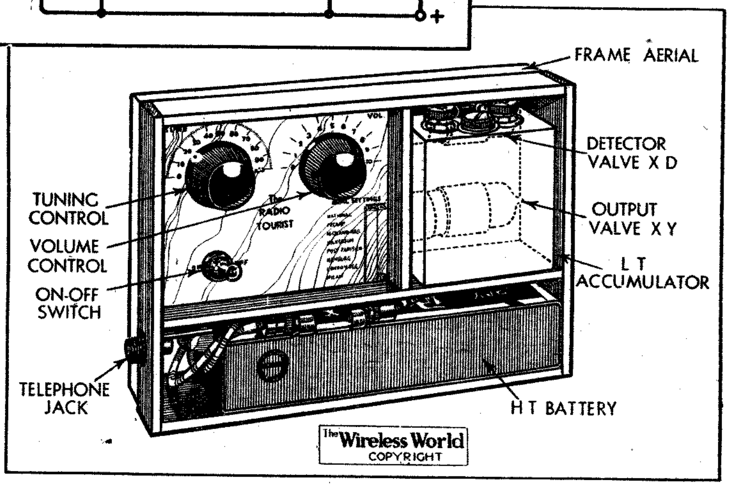
THE idea of a wireless set which can be concealed about the person is one which has never failed to stimulate the imagination of the general public. In the "Radio Tourist" a serious attempt has been made to give that idea practical expression. By calling upon the user to forgo on his part one or two of the features to which he has been accustomed in his permanently installed domestic receiver, the makers have succeeded in return in giving a really useful performance.

In the first place the wave-range of the set has been limited to the medium-wave band. This is a wise precaution, as the efficiency of the small self-contained frame-aerial is very much greater on the medium waves than it would be on the long-wave band. Secondly, the set is designed for use with headphones instead of a loud speaker, and as a result the simple two-valve circuit is able to supply all the volume required with a current consumption well within the capacity of the miniature HT and LT batteries.

The set was first tested in a steel-framed building in Central London. It is well known that marked differences in field strength are found within a few feet of each other under such conditions, but by first moving the set about to discover the blind spots to be avoided, no difficulty was experienced in getting good signals from the Brookmans Park stations with a moderate degree of reaction. As soon as the set was taken outside the building, however, a surprising improvement in signal strength was obtained, and at this distance (15 miles) very little reaction was required and very little attention was necessary to the directional properties of the frame in order to obtain full volume in the headphones. Subsequently the set was tried out in the Solent area. Here the tuning scale was predominated by the French broadcasting stations, and at least five were sufficiently strong to be tuned in with certainty by what might be described as casual methods. Even at this distance of approximately 75 miles the two London programmes were still available, though a good deal of attention to the reaction control was necessary, and allowance had to be made for hand capacity effects. The three-valve model with its additional LF stage would undoubtedly give the extra range necessary to ensure regular reception of weather forecasts, etc., along the South Coast, though in skilful hands the two-valve model might be expected to give reasonably good results on the East Coast. It is safer, however, to assess the normal working range of the model under review at 25 to 35 miles from a B.B.C. regional station, according to the degree of skill which is brought to the handling of the set.



There is nothing freakish in the two-valve circuit, the only deviation from conventional practice being the use of "throttle" reaction control instead of the usual series feed.



The various component parts of the set have been fitted into the Rexine-covered carrying case with considerable skill. Actually the over-all dimensions are $7\frac{3}{4} \times 5\frac{1}{4} \times 1\frac{3}{4}$, and the total weight is only $2\frac{3}{4}$ lb. The chassis occupies about half the available volume, and the panel is sunk so that the tuning knobs and switch are flush with the side of the case. The headphones, which, incidentally, are an extra, are connected through a plug and jack at the side. The fixing screw for the bush of the jack serves also to hold the receiver frame in place. The miniature valves are situated at the bottom of a compartment to the right of the receiver unit, and the LT accumulator fits over them, being separated from the glass by felt pads. At first sight this may seem a rather drastic procedure, but after due consideration we are convinced that it is quite practical, as the weight of the accumulator is small and it fits the case so closely that there is no chance of any movement developing which might cause damage to the valves.

The accumulator is of the jelly electrolyte type and has a rated capacity of 3 amp. hours. As the valves take only 0.2 amp., the continuous service on a single charge should be at least fifteen hours. The HT battery, which is little larger than a grid bias battery, supplies HT current at 36 volts, the consumption, according to measurements made on the model tested, being only 2.3 mA.

Although novel this receiver is no mere toy; its performance is such as to invite long and continuous use.

Letters to the Editor

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

Television Signals at 67 Miles

IT may interest you to know that the television transmissions are audible here at any time during the day from the Baird or EMI transmitters. The vision transmitter is stronger than the sound, which is spoilt by modulation hum, which so far I have been unable to cure, and almost drowns the speech, although the 1,000-cycle note, which is sent out for long periods, is easily audible.

The receiver consists of an autodyne SG frequency changer, three IF stages at 430 kc/s, diode detector, amplified AVC, and a three-stage 10-watt amplifier; aerial is a 74-foot horizontal wire with no down lead, the receiver being approximately 20ft. above ground level. I have not tried a dipole, which should give considerably greater signal strength.

I have also tried a 2-valve frequency changer, consisting of a separate oscillator and using suppressor grid injection to an ACVP1. This, however, was not so satisfactory as the autodyne, although over 10 metres it is much better, and is my normal frequency changer on short waves.

Other transmissions heard and identified by announcement between midday and 7 p.m. have been the second harmonics of JUH, W2XAD and W3XAL, and numerous police transmitters from U.S.A. around 9.5 metres. H. P. STAUNTON.

Felixstowe.

Interference from Rotary Converter

IT has occurred to me that an experience in the use of a DC-AC rotary converter may be of some value to other readers of your journal.

I have not seen the particular matter referred to in your "Hints and Tips" or "Readers' Problems" features, but as many of your readers must be using similar machines, the matter will be of some interest to them.

The difficulty has been to prevent strong interference from the converter when in use with a SW superheterodyne receiver. Although the machine is fitted with a good filter unit and silence cabinet, the interference, which was in the form of a strong machine gun-like ripple, occurred at frequent intervals, completely destroying any signal.

It was discovered that the source of the trouble was one of the brushes on the AC side. None of the usual cures had any effect. Ultimately it was found that the cause was due to the converter being *underloaded*. It is rated at 180 watts output, and was loaded to only 70-80 watts. As soon as a 100-watt lamp was added to the load the trouble ceased, and it has not recurred after three months' daily use. C. W. TIDD.

Sudan.

Operator's Problem

REFERENCE was made in the issue of October 16th of *The Wireless World* to a query you had received from a ship's wireless officer. As an ex-operator myself, perhaps my own experiences will be helpful.

What your correspondent appears to fail to understand is not that the signals from GBR (Rugby) on 18,740 get weaker at night, but that the signal to noise ratio decreases and atmospheric noise sometimes completely drowns signals from GBR during certain hours of darkness, which vary in time with the season and geographical position.

In the days when valve receivers were first supplied to ordinary vessels, as apart from the regular liners, a single valve was the rule, and a very poor one at that. Under good atmospheric conditions GBR was received at night regularly when beyond the daylight range (over 5,000 miles).

Again, with a two-valve receiver GBR was receivable right across the Pacific Ocean both day and night, with the exception of a small area on the 180th meridian during the winter in the Northern Hemisphere, but in summer was unreadable at all hours—being drowned by atmospheric noises—until within about 500 miles north of New Zealand, when conditions became better and signals quite readable.

Of course, there are parts of the world where, owing to high atmospheric noise level, GBR on 18,740 m. is hardly ever readable, whilst GIC on 36 m., with a very much lower power, is a really powerful signal.

The signals from the station GIA on, I believe, approximately 14 m., are very peculiar and seem to vary in different parts of the world in no regular manner, but, unfortunately, my observations of this station were not extended enough to form any definite opinion, and I should be glad to hear any of your correspondents' opinions on this.

Bath. B. M. TOWNSEND.

Television Scanning

CAN you, or any of your readers, tell me whether any attempt has been made to use reflecting surfaces on piezo-crystals for television scanning by direct illumination? I have protected the idea, but don't wish to waste time if it has already been tried and found wanting. R. L. SMITH.

South Shields.

Television Costs

I HAVE read with interest Mr. E. W. A. Mackenzie's letter in your issue of October 16th with regard to "Television Costs."

He has said much of what I have felt for a long time.

I think that if it were possible to take a census, not only from among the readers of your journal but also from among the huge majority of set owners who take in nothing better than the daily papers, it would be found that the most they could afford to spend on the domestic set is between £10 or £12, including the speaker.

For such, television receivers are out of the question; they might as well sigh for the moon.

It is not equitable for them to be called upon to bear the cost of a service the benefits of which they cannot enjoy.

To hark back for a moment to the controversy of a few years ago over the question of licence fees and the proportion withheld from the B.B.C. by the Treasury, you will remember that the fact that these fees were a payment on account of future entertainments was at the time generally stressed by the technical Press.

The legal right of the P.M.G. to withhold more than an amount sufficient to cover the expenses of administration was then questioned as being a diversion of money from the purpose for which it had been subscribed.

In these circumstances, I cannot help feeling that your editorial of October 16th is based to some extent on a misapprehension of the true position, and it would be of interest to hear what others think.

E. E. S. EARNSHAW-WALL.

London, N.W.2.

WHERE THE PUBLIC CAN SEE TELEVISION DEMONSTRATIONS

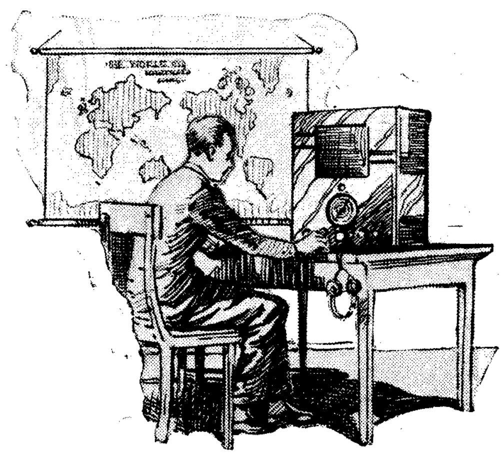
Place.	Particulars.	Accommodation.
Science Museum, South Kensington.	Free...	About 400
Waterloo Station	Free to railway ticket holders (Southern).	About 40
Army & Navy Stores, Ltd., 105, Victoria St., S.W.1.	Free...	Between 30 and 35
Bentalls, Kingston-on-Thames.	Demonstrations shortly.	—
Bon Marché, Ltd., Brixton Rd., S.W.9.	From Nov. 9th for two weeks, in the Restaurant.	—
John Barker & Co., Ltd., High St., Kensington, W.8.	Demonstrations shortly.	—
A. W. Gamage, Ltd., Holborn, E.C.1.	Free...	At least 100
Harrods, Ltd., Brompton Rd., S.W.1.	Free...	About 30
A. Imhof, Ltd., 112, New Oxford St., W.C.1.	Free...	250, in a Concert Hall.
Gramophone Co., Ltd., 98–108, Clerkenwell Rd., E.C.1.	By arrangement with their local H.M.V. dealer, readers of THE WIRELESS WORLD can have free demonstrations.	—
Murdoch, Murdoch & Co., 463, Oxford St., W.1.	Free, by invitation...	40–50
E. Rogers & Sons, Ltd., 56, 58 & 64, High St., Weybridge.	Free...	40
Royal Arsenal Co-operative Society, Ltd., various branches in S. London.	Free...	—
Selfridge & Co., Ltd., Oxford St., W.1.	Free. Appointments have to be booked.	8
Thomas Wallis & Co., Ltd., Holborn Circus, E.C.1.	Free...	40–50
Wm. Whiteley, Queen's Rd., Bayswater, W.2.	Free...	120

POPULAR FIVE-BAND RECEIVER.—The H.M.V. Model 481, which covers three short wavebands (7-16, 16.7-53, and 46-140 metres) in addition to the normal medium and long broadcasting wavelengths. Separate bass and treble controls are fitted. This model, which was inadvertently omitted from last week's classified list of all-wave receivers, is for AC supplies, and costs 18½ gns.

Short-Wave Listening

More Things Heard on the "All-Wave"

By "CATHODE RAY"



FOR the guidance of those who may be more or less experienced in medium- and long-wave reception, but are new to the "shorts," I have been pointing out the peculiarities of the latter, which call for a different tuning and listening technique. There is the fact that nearly 95 per cent. of the tuning scale is allocated to non-broadcasting services. And even the broadcasting transmissions, which presumably are the desired "catch," are subject to various special kinds of effects.

Some of the other sorts of transmission are not without a certain amount of interest. In fact, to those taking part in them, the amateur transmissions are, of course, the primary interest, broadcasting being regarded as so much unavoidable padding. Even the broadcast listener may be intrigued by the quaint *lingua franca* that enables amateurs of all nationalities to chat to one another understandably within certain limits of subject matter. But he is unable to sample more than a very dilute form of it, for it is chiefly in morse that this international medium of communication has been developed. The amateur bands are easy to remember, in approximate wavelengths, for, beginning at 160, they are obtained by successive halvings right down to 5 metres. This, by the way, has certain technical advantages. For instance, an aerial designed to respond primarily to 80 metres can be used effectively at 40, 20, etc.

"Machine Gun" Morse

Then there are police transmissions. With a regrettable lack of consideration of the public's entertainment, our own police communicate in code. And it is only during very exceptional conditions that one can join in the excitement of rounding up an American gangster. But over there the ability to "listen in on" the police is held forth as a definite inducement to buy a "Blank" radio.

It is nearly always possible to tune in some of the long-distance telephone conversations. These are fearfully distorted; so much so that, although they usually sound as if attentive listening would enable the words to be distinguished, and (perhaps) some bit of scandal to be disclosed, they remain curiously unintelligible. The conversationists, however, are—or should be, if there is no technical hitch—quite unaware that their voices sound to would-be eavesdroppers like the grunting of pigs, because the authorities obligingly undistort it all again at the receiving end. The technical term for the distorting process is "scrambling."

The various aforementioned varieties of speech, intelligible and otherwise, are decidedly in a minority on the short-wave bands. Both in number and power, morse predominates. And the most prominent transmissions are such that even expert telegraphists cannot make much of them, being high-speed automatic. Even though most of it is unmodulated, and therefore (as one would think) quiet, the keying clicks contrive to make a noise that might be likened to an exceptionally busy pneumatic drill or machine gun. These transmissions carry some of the telegrams that at one time had to go by cable.

Going back once more to intelligible programmes, and considering their afflictions, there is fading. On the longer waves it usually takes from several seconds to several minutes to go through one complete fade. On short waves it seldom takes much more than a second, and commonly much less. The distortion that occasionally takes place on longer waves is also characteristic. The effect of fairly rapid fading, with the background noise consequently coming up each time, produces a sound frequently mistaken by the non-technical listener for the Atlantic billows over which the transmission is passing. It is generally accompanied by changes in the tone of the reproduction very much like that due to periodical mistuning.

Although it is conceivable that people who live in countries where there are medium- and perhaps also long-wave programmes might turn to short waves for sustained listening, I suspect that the object generally is to identify some far-off station. That being so, there is value in any clues by which to distinguish distant programmes from comparative locals. It is irritating to spend a quarter of an hour listening for an announcement and then finding that the time has been wasted on Daventry or Zeesen.

It is not nearly so easy to form a reliable estimate of distance on short waves as on the longer ones, for strength of reception and fading are very uncertain indications. It is quite common for stations in America or even farther away to be stronger and steadier than those at short range. Daventry at sixty miles often fades badly. But the "seashore effect" is a moderately reliable clue to a distant station. The mistuning or "apparently swinging aerial effect" is an even safer guide. Sometimes by great efforts in precise tuning one picks up an extremely faint and presumably enormously distant programme, only to find with disgust that it is the National or Regional. It is probably a harmonic of the local station. It is as well to make a note of each sub-multiple of the local station's wavelengths, so as to keep out of this trap. A further safeguard against them, and also such Empire transmissions as are doing the same programme, is to have means of rapid reference to whatever they are sending out at the moment, so as to compare it with the programme under examination.

Globe-Trotting Signals

One of the most remarkable short-wave phenomena that can be observed is a striking illustration of the fact that reception does not become progressively weaker the greater the distance from the transmitter. Occasionally, programmes from the local Empire transmitters, particularly those working on the shortest wavebands, appear to be issuing from a large bare cavern giving such a fearful echo that it is difficult or impossible to make out a word of what is being said. Knowing the care the B.B.C. takes over such matters as studio acoustics, it may not be easy to imagine the cause of such a defect; and it may be still more perplexing to know that the same programme received in Australia or wherever it is aimed at is probably quite normal!

It *is* an echo, but on an enormously greater scale than the usual sort. It is due to waves going round the world, perhaps several times, and arriving at the receiver an appreciable fraction of a second later than those coming direct. Once round the world takes a seventh of a second, but I have heard echoes following at decidedly greater intervals—almost as if a second speaker were butting in. Of course, it is only noticeable under conditions which render the direct wave abnormally weak and the globe-trotting waves exceptionally strong.

If you use your imagination, there is surely something very impressive in such a result as this. You are listening to a speaker whose voice literally runs around the world and echoes to and fro in it. A man is talking, and his auditorium is vastly greater than any the classic orators dreamed of. The last time I heard this world echo, the speaker was soliloquising on the feeling of uncertainty, when talking to the ends of the earth at queer hours of the night, as to whether anybody was really listening. If he could have heard, as I did, the etheric vaults sending back his voice, it surely would have given the right dramatic atmosphere for his words!

Listeners' Guide for

IT is doubtful whether at any other time during the year there is such unanimity among listeners as on November 11th. Armistice Day is again marked this year by commemorative programmes.

In the morning the ceremony at the Cenotaph will be broadcast. This begins at 10.25 and ends at 11.10, and will be heard on National and Regional wavelengths. The massed bands of the Brigade of Guards will be heard playing appropriate music prior to the Two Minutes' Silence which will be followed by a short service conducted by the Bishop of London.

The evening programmes from 8 to the early closing down at 10.5 will also be radiated by both National and Regional stations. At 8 listeners will be switched over to the British Legion Festival of Empire and Remembrance at the Albert Hall. The programme opens with a fanfare of trumpets by the trumpeters of the Household Cavalry, after which comes the singing of the National Anthem. Then follows the entry of the various sections of the Services. The scenes will be described for listeners by Capt. H. B. T. Wakelam. Immediately following this, at 9.10, a special studio broadcast will be produced by Val Gielgud.

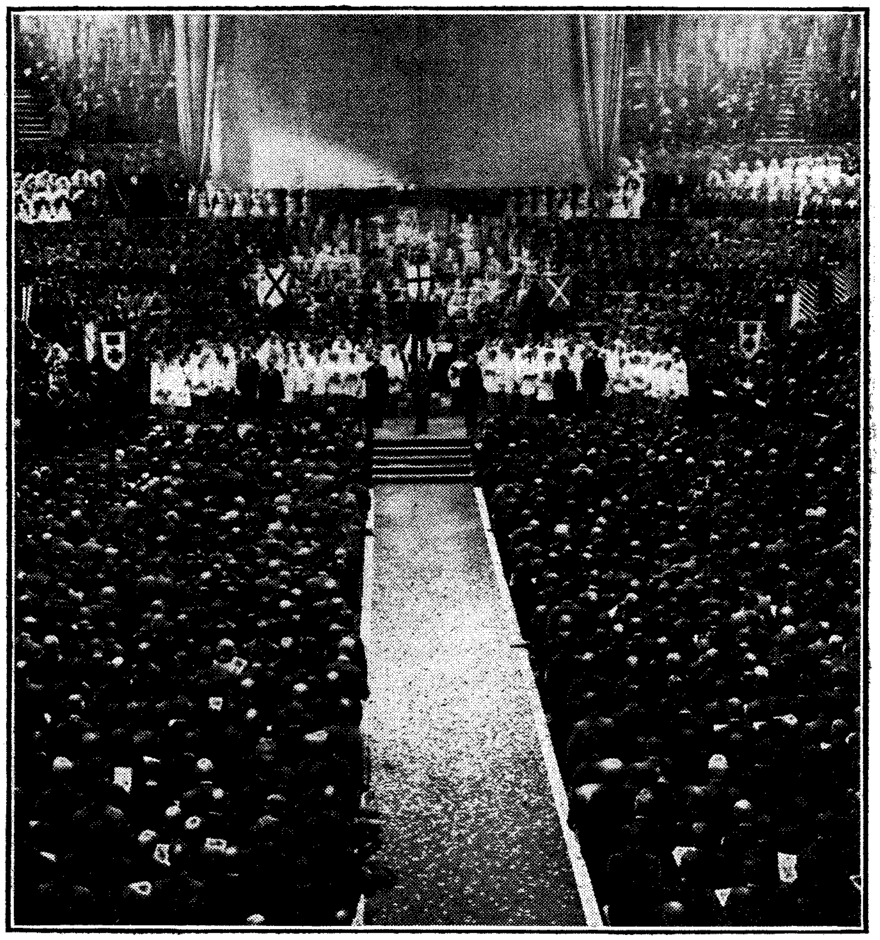
Through the medium of music, poetry and drama, it is hoped to create a period of mental solace for those who suffered loss through the war and for those who hope that war may not come again in their time.

◇ ◇ ◇

RICHARD STRAUSS

TWICE during this week listeners are to be treated to broadcasts conducted by the great composer, Richard Strauss. He first appears to-night (Friday) at 8.30 and 9.30 (Reg.) conducting his opera "Ariadne on Naxos," played by the Dresden State Opera Company at Covent Garden. The Prologue to this one-act opera has its scene set in a spacious but sparsely furnished hall in the town mansion of a great noble, with the Island of Naxos as the scene for the opera.

On the following afternoon in the Queen's Hall at 3.15 (Nat.) Strauss will be heard conducting the Dresden State Opera Orchestra in a concert of his own compositions, including "Till Eulenspiegel" and "Don Quixote."



LEST WE FORGET. The scene during a previous Festival of Empire and Remembrance which will, for the seventh year, provide a large part of the Armistice Night programme.

◇ ◇ ◇

ANOTHER SCRAPBOOK

THIS time the collaborators, Leslie Baily and Charles Brewer, have chosen the year 1908 for their eleventh Scrapbook programme to be given on Tuesday and Wednesday at 8 (Reg.) and 7.30 (Nat.) respectively. It was a big musical comedy year, including the "Waltz Dream," "The Merry Widow," and Leslie Stuart's "Havanna." The suffragettes were showing great activity, and the year included the famous trial at Bow Street of Mrs. Pankhurst, Miss Christabel Pankhurst and Mrs. Drummond. These and many other features of 1908 will be presented in this programme.

MADAME FLORENCE BAGA DE JONG, of the New Gallery Cinema, who will be the first lady to play the B.B.C. Theatre Organ when she broadcasts to-night at 9.40 (Nat.).

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SPORTS COMMENTARIES

FROM the Empire Pool and Sports Arena, Wembley, Lionel Seccombe will give a punch-by-punch description at 9.35 on Monday of the match between John Henry Lewis (the holder) and Len Harvey for the Light-Heavyweight Championship of the World.

On the following evening what is undoubtedly the fastest game will provide a commentary for Regional listeners at 9.30. It will be the occasion of the ice-hockey match between Earl's Court All-Stars and Toronto Dukes in the Empress Stadium, Earl's Court.

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THE DEAF HEAR

Wireless World readers are familiar with the work of the Department of Education of the Deaf at the University of Manchester by reason of the articles which have appeared in the pages of this journal. A talk on this work entitled "Science is Helping the Deaf" will be given by Irene R. Ewing for National listeners on Thursday at 8.15.

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ADVERTISING

"THAT advertising is a burden to industry and harmful to the community," is the motion on which a debate takes place on Saturday at 9.20 (Reg.). The proposer will be C. P. Snow, Fellow and Tutor of Christ's College, Cambridge, and he will be opposed by Barrington Hooper, a well-known publicist, whose activities have included the organisation of the War Bond Tank Campaign in 1916, the Victory Loan, and the Food Economy campaign. Sir Michael Sadler will be chairman. The subject is a very controversial one, and this debate should be listened to by all who enjoy a battle of wits.

Details of the week's Television programmes will be found on p. 478.

the Week

Outstanding Broadcasts at Home and Abroad

HIGHLIGHTS OF THE WEEK

FRIDAY, NOVEMBER 6th.
Nat., 5.15 The Continentals. 6.25, Recital: Mrs. Tobias Matthay (poetry) and Tobias Matthay (piano). 8, The White Coons.
Reg. 6, Alfredo Campoli and his Orchestra. 7.30, Savoy Hotel Orpheans. 8.30 and 9.30, The Dresden State Opera.
Abroad.
Radio-Paris, 8.45, "Le jour et la nuit," three-act opéra-bouffe.

SATURDAY, NOVEMBER 7th.
Nat., 3.15, Dresden State Opera Orchestra. 6.45, Brian Lawrence and his Dance Orchestra. 7.30, "In Town To-Night," 9.20, Music Hall, including Billy Bennett, and Wee Georgie Wood.
Reg., 4.15. The White Coons. 7.30, The Broadhurst Septet. 10.25, Henry Hall's Hour.
Abroad.
Kalundborg, 7.40, A Trip round Copenhagen's Restaurants and Amusement Centres.

SUNDAY, NOVEMBER 8th.
Nat., 5.30 The Prague String Quartet. 6.30, "The Table Under the Tree." 7.55, Service from St. Martin-in-the-Fields.
Reg., 5, Callender's Senior Band. 6, The Vienna Wireless Orchestra —from Vienna. 6.30, Sunday Orchestral Concert
Abroad.
Leipzig, 7, Leipzig Symphony Orchestra—opera and light music.

MONDAY, NOVEMBER 9th.
Nat., 7.20, "The Music Shop"—III. 9.20, The Lord Mayor's Banquet.
Reg., 6.40, From the London Theatre. 8, From Jungle to Jazz. 9.35, Boxing Commentary.
Abroad.
Strasbourg, 9, Soudant Society's Concert from the Salle Braun, Metz.

TUESDAY, NOVEMBER 10th.
Nat., 6.25, 'Cello Recital: Anthony Pini. 7, "Feminine Fame." 9.40, "The March of the '45."
Reg., 7.30, B.B.C. Dance Orchestra. 8, Scrapbook for 1908. 9.30 Ice Hockey Commentary
Abroad.
Paris PTT, 8.30, "Boris Godunov" from the Salle Pleyel.

WEDNESDAY, NOVEMBER 11th.
Nat., 10.25, a.m., Relay from the Cenotaph. 7, B.B.C. Orchestra (E) and William Parsons. 8, Festival of Empire and Remembrance from the Albert Hall.
Reg., 6, B.B.C. Dance Orchestra. 7.50, "The World Goes By."
Abroad.
Strasbourg, 8.30, Armistice Day concert from the Palais des Fêtes.

THURSDAY, NOVEMBER 12th.
Nat., 6.40, "The Young Broadcasters" 7.30, Scrapbook for 1908.
Reg., 7.30, Variety—Fiftieth Broadcast from the Empire Theatre, Belfast. 8.30, "The March of the '45."
Abroad.
Munich, 9.40, German Folk Songs.

"THE MARCH OF THE '45"

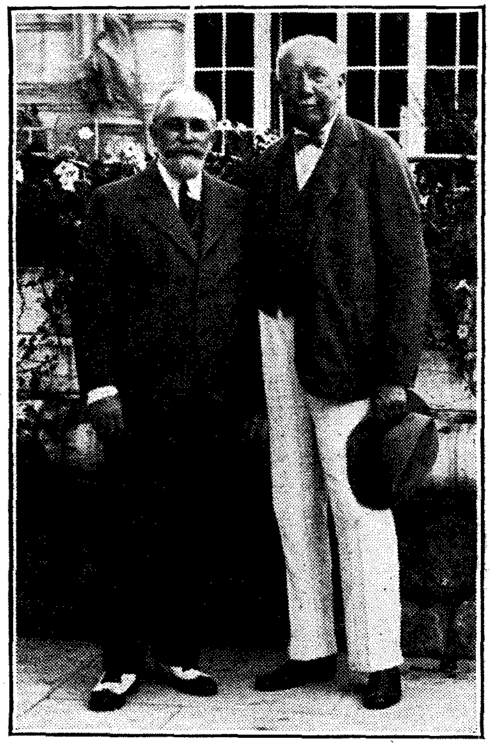
The North and Scottish Regional stations are combining in the revival of D. G. Bridson's feature programme, with the above heading which was broadcast last February. It is to be given on Tuesday at 9.40 (Nat.) and on Thursday at 8.30 (Reg.). It takes the form of a radio programme in verse and song, in which the march of Prince Charles Edward is followed from the landing at Loch Nan Uamh to the final defeat at Culloden. Part I comes from Scotland, Part II from the North, and Part III is shared by the two Regionals.

FROM MOSCOW

To-night (Friday) being the eve of the nineteenth anniversary of the October Revolution, Moscow will be ablaze with light and colour. Hundreds of thousands of its citizens will be parading the streets, rejoicing on this anniversary. Short descriptions in English of the scenes will be broadcast from 9-10 by Moscow. Between these descriptions will be heard some of the bands, national dance music and popular songs with which the streets will be ringing.

OPERA

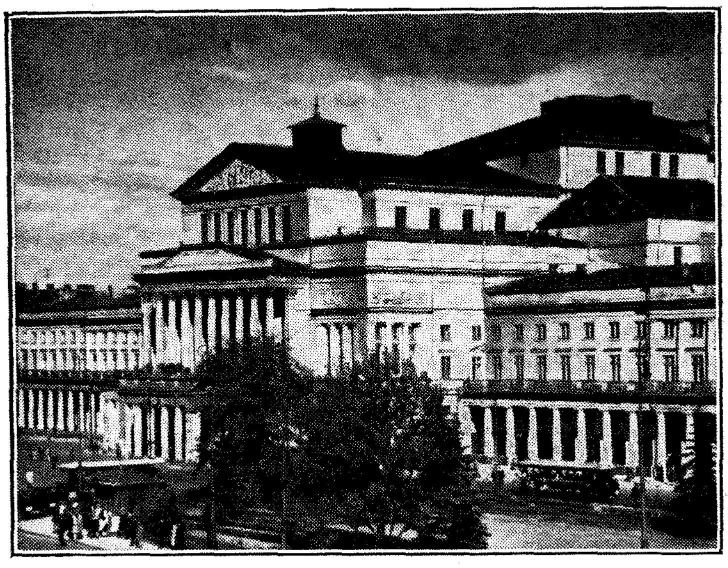
On Friday (to-night) Warsaw honours a national composer, Kurpinski, by relaying "The Forester of Kozienica" at 7.15. Frankfurt and Stuttgart offer a magnificent performance of Verdi's "Othello" at 11 the same evening by the cast of La Scala, Milan.



RICHARD STRAUSS, here seen with M. René Chauvet (left), Director of the Vichy Casino, will twice this week be conducting the Dresden State Opera Orchestra.

Radio-Paris gives the delightful "On ne badine pas avec l'amour" by Pierné at 8.45 on Saturday. Mussorgsky's famous opera "Boris Godunov" will be given by Paris PTT and other French stations at 8.30 on Tuesday.

Frankfurt and Stuttgart on Wednesday night at 11 again offer a recorded version of a classical opera. This time it is Mozart's "The Magic Flute."



THE OPERA HOUSE, WARSAW, whence will be heard Kurpinski's "The Forester of Kozienica," relayed by Warsaw.

For those who may wonder why November 7th is the anniversary of the *October* Revolution, it is perhaps worth mentioning that Russia was using the Old Style calendar at that time.

VIENNA

A new series of Adult Education programmes will be launched by the Danish broadcasting organisation on Sunday at 8.10 under the heading of "World Cities Described in Word and Music," and the first city to be dealt with will be Vienna. The broadcasts will take the form of lectures with "incidental" music.

THE REFORMATION

Four hundred years have passed since the Reformation took place in Denmark and to-night (Friday) Kalundborg relays a concert of ecclesiastical music at 7.10 from the ancient cathedral Vor Frue, of Copenhagen.

DANISH "IN TOWN TO-NIGHT"

The Scandinavian countries are always keeping a close watch on the B.B.C., with the result that British broadcasting ideas are very often adopted by Scandinavian programme directors. The latest is that Denmark has found it worth while trying the "In Town To-night" feature in Copenhagen on Wednesday at 8.45.

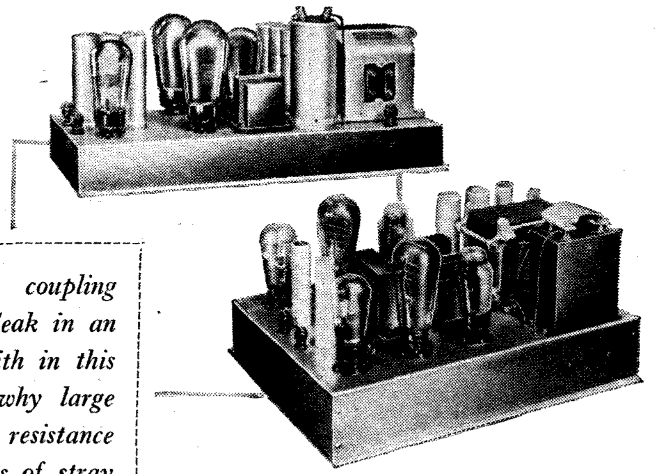
BIRTHDAY CONCERTS

From Berlin on Sunday at 7 comes a concert in honour of the seventieth birthday of Paul Lincke, who is the most popular composer of light music and operettas in Northern Germany.

Another septuagenarian birthday concert comes from Frankfurt on Thursday at 10. This time it is in honour of Georg Schumann, who will conduct the station orchestra.

The Auditor.

Resistance-Coupled Amplifiers



Part II.—The Coupling Condenser and Grid Leak

THE action of the coupling condenser and grid leak in an RC amplifier is dealt with in this article, and it is shown why large values of capacity and resistance are necessary. The effects of stray circuit capacities are also considered.

AS explained in Part I, it is customary to join the anode of one valve to the grid of the next through a condenser in order to isolate the grid from the HT supply. A grid leak is also used to permit the application of grid bias to the second valve. This arrangement is shown in Fig. 4, and it is in regard to the action of the new components C1 and R2 that much confusion arises. It is, for instance, commonly stated that the capacity of the condenser and the resistance of the grid leak must be large if the lower frequencies are not to be attenuated. This is quite correct, but a large capacity and a high resistance mean that the time constant of the combination is high, and it is often believed that this will prevent high frequencies from being dealt with faithfully. This idea is quite erroneous, but there is some excuse for its prevalence since it is admittedly sometimes difficult to see how a circuit with a high time constant can deal with the rapidly changing potentials found at high frequencies.

It is consequently necessary to investigate the circuit in some detail, and to do this we shall go back to first principles and see what happens in the various parts of the circuit. Consider first of all the arrangement of Fig. 4 under static conditions. The voltage and current distribution around V1 are exactly the same as in the case of the simpler circuit of Fig. 1 (Part I), for the new components C1 and R2 in no way affect the direct current circuit of V1. Using MHL4 valves with -4 volts grid bias and 290 volts HT as before, therefore, the anode of V1 is at a potential of 146 volts with respect to its cathode when R1 has a value of 25,000 ohms.

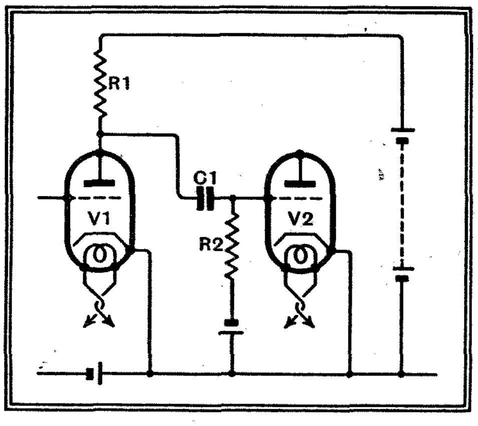


Fig. 4.—A typical RC coupling, showing the coupling condenser C1 and the grid leak R2.

Now, the grid of the second valve is returned to its cathode through the resistance R2 and the bias battery, which we shall again assume to be -4 volts. As the valve receives a negative grid bias it does not pass grid current, and there is no current flowing through R2; the bias on the valve is consequently unaffected by the value of R2 and is equal to the voltage of the battery. We can, therefore, make R2 any value we like without affecting the bias on V2.

It will be observed that, since the left-hand plate of C1 is joined to the anode of V1 and the right-hand plate to the grid of V2, the voltage existing across it is the difference between the anode and grid voltages measured with respect to the earth line. In the case which we are using as an example, the voltage across C1 is thus $146-(-4) = 146+4=150$ volts. The condenser is consequently charged and stores a quantity of electricity, the exact amount depending upon its capacity and upon the voltage across it.

Now suppose that we change the grid potential of V1 by a fixed definite amount; suppose we change the bias to -2 volts. We know from Part I that V1 will pass a greater anode current and that its anode voltage will be lower; actually the current will rise from 5.76 mA. to 6.87 mA., and the voltage will fall from 146 volts to 118 volts. The conditions in V2, however, are not affected in any way, but there is now a potential of only 122 volts across C1, and it consequently stores a smaller quantity of electricity than before. The conditions as regards V2 are exactly the same before and after the change, but are they the same while the change is actually taking place?

While the anode current of V1 is increasing in value, the potential of the anode and hence the voltage across C1 are falling. But the electricity stored in a condenser cannot be discharged instantaneously; a certain time is always needed for the discharge of a condenser, and the larger the capacity, and the higher the resistance of the path through which it must discharge, the longer it will take.

The Coupling Condenser

Now if R2 is of very high value, so that the total resistance between the two sides of the condenser is very large, the condenser cannot change its charge quickly. When the anode potential of V1 falls, therefore, the potential of the left-hand plate of C1 changes in a negative direction, that is, electrons flow into it. Electrons are consequently repelled from the right-hand plate, leave it and accumulate on the grid of V2. We see that when the anode potential of the valve changes in a negative direction, that is, falls, the left-hand plate of C1 acquires a negative (or less positive) charge, and the right-hand plate an equal positive charge. The grid of V2 is not at the same potential as the right-hand plate, but at an equal and opposite potential, for the electrons driven out of the right-hand plate, by virtue of which it becomes positive, must accumulate on the grid and make it negative, for if R2 is infinite there is nowhere else for them to go. When R2 is not infinite a certain proportion of them escape through it, and the voltage on the grid of V2 is reduced.

It can thus be seen that while the grid potential of V1 is being changed so that the anode current is rising and the anode voltage falling the grid potential of V2 is also changing and moving in a more negative direction so that the anode

Resistance-Coupled Amplifiers—

current of this valve falls and its voltage rises. When the change is accomplished, the conditions in V1 settle down to new values, and the electrons accumulated on the grid of V2 gradually leak away through R2 so that the grid potential of this valve returns to its normal value. It will, of course, be clear that had the initial change of grid voltage to V1 been taken in the opposite sense the changes throughout would also have been opposite.

The conditions are illustrated diagrammatically in Fig. 5. The initial grid and anode potentials are represented by the lines *a* and the final potentials by the lines *b*. The changing conditions are represented by the lines joining the *a* and *b* lines. Two sets are shown for the grid potential of V2, for large and small values of C2 and R2, and it will be seen that with large values the grid potential tends to remain at a different value for an appreciable time before returning to normal.

Now, in practice we are concerned with alternating current of various frequencies; neither current nor voltage is steady, but is continually changing in value. It is, therefore, not difficult to see that the grid of V2 can faithfully follow the anode voltage excursions of V1. As long as the grid voltage of V1 is changing the anode voltage of this valve is changing, and there is consequently a varying electron flow into or out of the left-hand plate of C1. As a result electrons are repelled from or attracted to the right-hand plate in a varying degree and move to and from the grid of the valve, the potential of which varies in a negative or positive direction. This process is carried out to perfection if R2 is infinitely high in value or if C1 is of infinite capacity, for then the full number of electrons which move in or out of C1 affect the grid and there is no loss through R2.

In practice R2 is necessary, but the loss in it is negligible if the values of R2 and C1 are large enough, for it takes time for the charge to leak away. If the time constant (R2 C1) is large compared with the time taken by the signal impulse which it is desired to amplify, then R2 has a negligible effect. This is easily seen, for if R2 were infinite, and the grid potential of V1 were changed to a new fixed value, then, as already explained, the grid potential of V2 would change, but it would remain indefinitely at that new value, for the charge on the grid would have nowhere to leak away. In practice, of course, an infinite value for R2 is impossible, for there is always some leakage across the valveholder and valve itself. It is, however, quite possible with a little care to insulate the grid of V2 so well that it will hold a charge for several seconds at least. For reliable operation, however, it is necessary to avoid extremes in component values, and R2 must be given a value much lower than the insulation resistance of other components. If this is not done the operation will be inclined to vary from day to day, since the insulation resistance is likely to vary with the humidity of the atmosphere.

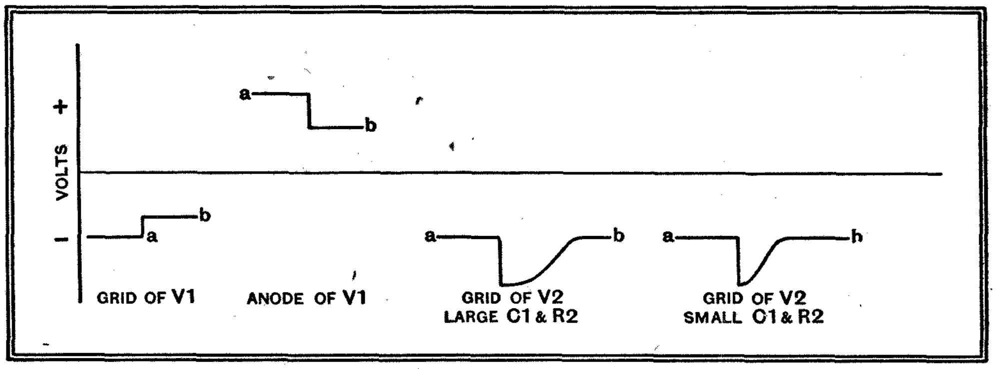


Fig. 5.—The voltage changes on a valve are clearly shown here. If the grid voltage is changed from (*a*) to (*b*), the anode voltage changes in the opposite sense. The grid voltage change of the following valve depends on the values of the coupling components and varies in the manner shown.

Efficiency of the Coupling

It is not generally convenient to work in terms of the circuit time constant, for the reason that calculation of circuit values is much more easily carried out by means of impedance calculations on the assumption that the voltage variations follow a sine law. On this basis, which is equally accurate, the coupling efficiency given by C1 and R2 is equal to $R2/\sqrt{R2^2+1/\omega^2C2^2}$ where $\omega=6.28$ times the frequency. When inserting values, resistance must be in ohms, capacity in farads, and frequency in cycles per second, and indeed this holds for all equations unless otherwise stated.

Under normal operating conditions it is not possible to use too large values for C1 and R2, unless, of course, the valve maker places a limit to R2. However large they may be, the performance will not deteriorate at any frequency. Under abnormal conditions, however, large values may be a disadvantage. If too large a signal is permitted to reach the grid of V2, this valve may pass grid current and the condenser C1 will acquire a charge. The grid potential will become much more negative than usual and, as long as the charge on C1 lasts, V2 may have such a heavy bias that very serious distortion results. The time which the charge lasts depends on the time constant R2C1, and the smaller this is the quicker will the charge leak away and normal operation be restored.

When an amplifier is properly operated on broadcast transmissions, the input to a valve should never be large enough for this effect to occur, and experience shows that it is possible to use large enough values for the components to enable the response to be maintained down to as low a frequency as 20 c/s without any trouble from this effect. For distant reception under conditions of bad atmospheric or severe local interference, however, it is another matter, and with large values for R2 and C1 a sudden peak of interference may easily overload a valve so that it passes grid current, and the receiver may then be momentarily paralysed. If several such peaks of interference follow one another the set may be almost out of action until they have passed. The effect has, however, the advantage of acting as a volume limiter on very severe interference.

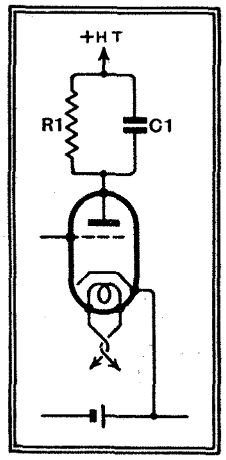


Fig. 6.—The stray capacities can be represented by a condenser C1 in parallel with the coupling resistance.

At low frequencies the response of the amplifier is determined by the relative values of the coupling condenser and grid leak, and, as already explained, there is no difficulty in making the loss negligible at the lowest frequency required. This portion of the coupling can cause no loss at high frequencies, and the upper limit of response would consequently extend indefinitely were it not for the effects of stray capacities. It is inevitable that there should be some capacity shunting the coupling resistance, and this is made up of the anode-cathode capacity of V1, the grid-cathode capacity of V2, and the stray wiring capacities.

We can represent these capacities with sufficient accuracy by shunting R1 of Fig. 1 by a condenser; this gives us the arrangement of Fig. 6. Under static conditions, the capacity C1 has, of course, no effect, and the voltage between its plates is that across R1, perhaps 144 volts, to take the example we have been using. Now suppose that the grid voltage is changed suddenly to a new value such that the anode current would rise and the anode voltage would fall from 146 to 118 volts if C1 were absent. This means that the voltage across R1 would rise to 172 volts. As soon as the voltage across R1 rises, however, C1 starts to take current, for, with a higher voltage applied to it, it can hold a greater quantity of electricity. This current must come from somewhere, and it actually comes through the valve. Instead of the valve current being equal to that through the resistance it is equal to the sum of the current through the resistand and the current taken by the condenser. Although the valve current may be slightly larger than if C1 were absent it is true to say that the condenser robs

Resistance-Coupled Amplifiers—

the resistance, and the current through the latter is less than it would be if C1 were not connected across it. Hence the voltage drop across it is also less.

This refers only to the instantaneous condition, of course, but it is easy to see that the whole time the grid voltage is changing and the anode current is rising the condenser is taking current, and the changing voltage across C1 is less than if this component were absent. When the grid voltage is changed in the reverse direction the anode current falls, and the voltage across R1 falls also. The condenser C1 must then reduce its charge by discharging through R1, and this naturally means that the current through R1 does not fall as rapidly as it should.

After a small fraction of a second these effects disappear, and if the grid voltage be held at its new value the voltage and current distribution will be the same as if C1 were not present. Under normal operating conditions, however, the input to the valve is continually varying, so that C1 always plays some part. If the input voltage changes slowly so that the condenser is given time to adjust its charge, then it has a negligible effect. But if the grid voltage changes are very rapid the condenser charge can only change a little before that half-cycle is over and the next, of reverse polarity, comes along and tries to make it vary in the opposite direction. The charge on the condenser cannot then change rapidly enough to keep up with the grid voltage changes on the valve, and, in consequence, the voltage changes across R1 are not as large as they should be.

It can be seen, therefore, that if the response is to be maintained at high frequencies the condenser must be able to change its charge very rapidly. The ease with which it can do this depends on its capacity and upon the value of the various resistances of the circuit, and the larger these are the slower is it in responding to variations in current.

THE RADIO INDUSTRY

TEWKESBURY ABBEY has recently been wired for sound reinforcement; a G.E.C. 14-watt speech amplifier is used, together with two moving-coil microphones, two projector speakers and two small cabinet speakers.

Exclusive designs for cabinets are shown in a new catalogue issued by Halford Radio, 39, Sackville Street, Piccadilly, W.1. These designs include examples of modern and "period" styles.

Reception of Sir Malcolm Campbell's television broadcast was carried out on a large scale by Marconiphone in the Exhibitors Club at Olympia during the recent Motor Show. The demonstration was witnessed by about 120 people.

RANDOM RADIATIONS

By "DIALLIST"

Record Range for A.P. ?

THE report (so far unconfirmed) that a Johannesburg amateur has received signals from the Alexandra Palace raises a whole crop of interesting points. It is stated that so far from being feeble the signals were as strong as those normally picked up from the Daventry Empire transmitters. Though there is no doubt that intervening hills and even buildings can act as very effective screens to ultra-short-wave transmissions, the original belief that these waves are quasi-optical in character seems no longer completely tenable. Reception from the London Television Station has, in fact, been reported from Bournemouth and several other localities in which, theoretically, it should not have been possible. A long time ago I predicted in these notes that when more experimental work had been done on the ultra-shorts it might be found that impulses reappeared again outside a "skip area." That is what seems to have happened. Future investigations may tell us the size of the skip area, and whether it varies at different times and seasons.

Is D X Television Possible ?

Ten years or more ago, when television was in its early infancy, it was boldly foretold that ere long we should be able to "look-in" at test matches in Australia. This idea was ridiculed, particularly when it became evident that the future of television was inseparably bound up with the ultra-short waves. But now that transmission on wavelengths as low as 5 metres have been received at enormous distances, does world-wide television become a possibility? One understands that outside the normal service area of 30 miles or so synchronisation becomes more and more of a problem. The Johannesburg experimenter has not a television receiver, so that it is not known whether the synchronising pulses would be adequate in South Africa.

"An Operator's Problem"

SEVERAL correspondents have been kind enough to send me suggested explanations of a problem mentioned in these notes some weeks ago. It may be remembered that a ship's wireless officer reported that at distances over about 1,500 miles the 18,750-metre signals from Rugby were well received in daylight but poor, or even quite unreceivable, after dark. He asked whether anyone could give a reason for this. One reader suggests that "normal behaviour," that is, almost equally good reception at all times, is the property of only a limited band of wavelengths between, possibly, 1,000 and 5,000 metres. As you reduce the wavelength below 1,000 metres the effects of daylight and darkness become more and more noticeable. He thinks that similar queer goings-on are to be expected as you increase the wavelength above what may be called the upper limit of normality. Reducing the wavelength brings you nearer and nearer to the frequencies of light; increasing it takes you farther away from light and closer to sound. What are your views?

Battery Standardisation

IT seems to me rather a pity that those who design battery sets can't come to some agreement about the working HT voltage. As it is we have all kinds of queer voltages required by different sets: 120 (including grid bias), 120 (not including grid bias), 135, 150, 165, and so on. Battery valves are pretty well standardised; most makers publish replacement lists showing which of their valves will do the same work as the equivalent product of other makers. This being so, the same working HT voltages should be satisfactory all round. It would be a great advantage to set users if all portables were designed for a 120-volt HTB and all non-portable sets for, say, 150. There would then be no trouble about getting a replacement battery anywhere when one was required. It would also be a boon if agreement could be reached about matching the capacity of the HTBs supplied with sets or needed for renewals to the load imposed on them: say standard capacity for loads up to 8 milliamps, medium capacity for those between 8 and 12 milliamps, and large capacity for bigger loads. Running costs would then be far easier to work out.

Little Pictures, Loud Noises

WHILST engaged in watching reception of the television programmes in recent weeks, I've been rather struck by the incongruity of presenting Lilliputian human figures on the viewing screen and providing them with Brobdingnagian voices! This defect was first pointed out in a leader in *The Wireless World* as far back as April, 1935. The other day, for instance, I watched Miss Jasmine Bligh and Mr. Leslie Mitchell having a dancing lesson. The televised Miss Bligh was, I suppose, some four inches in height, but when she opened her minute lips the loudspeaker endowed her with a voice that was rather more than full sized. Strictly speaking, I take it, we should reduce the sound to match the image, or magnify the image to suit the sound. Neither of these alternatives is, however, quite practical politics. Luckily, the human eye and ear are very accommodating in their association. After a while one ceases to notice anything very peculiar about a midget dance band producing volume enough to fill a biggish room, or a tiny motor car, no bigger than a nursery toy, having an ear-splitting exhaust roar.

Keeping a Check on Valves

FEW of us in practice keep sufficient check on the condition of our valves, and that is rather a pity, for a "tired" valve can ruin the performance of any set. It is very easy to discover whether your valves are up to the mark or not if you care to make up a little testing panel such as I constructed years ago. In its simplest form for triodes it consists of a valve-holder and four pairs of terminals. The first pair are for a plate-circuit milliammeter, the second for a 100-volt high-tension battery, the third for a 2-volt (or 4-volt) accumulator, and the last for a grid battery. The important thing to know about valves is the mutual conductance, which is found by dividing the change in grid volts into the change in plate current. Now suppose that we take a reading of the milliammeter with the grid at zero volts and then make the grid one volt negative and re-read; it is obvious that the mutual conductance is the difference between the two readings (change in plate current), since the divisor (change in grid volts) is one.

Obtaining 1-volt Negative

Thinking for the moment of battery valves, how is one to obtain a negative bias of one volt on the grid? Actually it's quite easy, without using any special kind of cell. Use a 3-volt dry grid battery and connect its positive to LT positive. Then the grid potential is $+2$ volts -3 volts $= -1$ volt. A simple switching arrangement enables you to turn instantly from zero grid bias to one volt negative. My suggestion is that a valve when brought into service should be tested in this way and its mutual conductance noted on a piece of stamp edging stuck on to bulb or cap. There's then no difficulty in seeing how it is getting on when it is re-tested under similar conditions in, say, six months' time.

The Importance of Band-spreading

THE other evening I was at the house of some friends, who complained that they had never yet heard an American station on the short-wave range of their "all-wave" set installed a month or two previously. Could I show them how it was done? I *did* succeed in getting W2XAD at good loud speaker strength, but it is some years since I have had to do so difficult a feat of fine tuning. The slow-motion dial wasn't so very slow and, what was worse, it had a serious amount of back-lash. As the set had no RF stage, and wasn't particularly sensitive, you can imagine what I was in for! Just to see what would happen, I told them the setting of the station as near as it could be read on the rather small dial and asked them to try their hands at tuning it in. They failed completely to find it at all! I am quite sure that any "all-wave" receiver intended for use by the ordinary man or woman should have effective band-spreading on the short waves. Absence of this is apt to mean that the short-wave range is given up as too hopelessly difficult by Mr. and Mrs. Everylistener.

Period Pieces

MY fancy is always immensely tickled when I read of such a thing as a Jacobean wireless set or a Chippendale radiogram. One pictures the gay Stuarts twiddling the knobs, imagines Mr. Samuel Pepys as Director Generall of the Brittish Broadcastinge Corporacion (of which high post he would have made no small success), or dreams of the great Doctor Johnson discoursing to Mrs. Thrale on the curse of crooning! "Crooning, Madam," he might have said, "is the noise produced by those who cannot sing but will. 'Tis said that swans sing before they die; it were no bad thing could these crooners die before they sing."

Radiogram, by the way, is a queer word that has entirely changed its meaning in recent years. It used to mean a telegram sent by wireless. If I remember aright, they were called Marconigrams first, and, later, radiograms. What is the correct term nowadays I don't think I know. But I did hear one man say the other day that he had received a wireless cablegram—which, somehow, didn't seem quite right.

Scottish Regional and Burghead

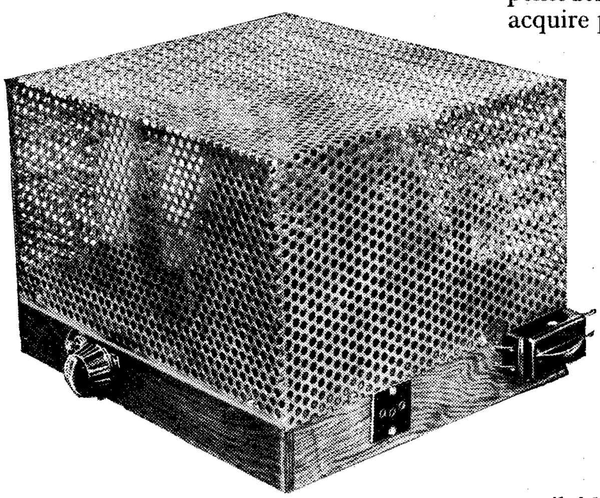
I QUITE expected to find "common-wavelength wobble" pretty badly in evidence when I tuned to the Scottish wave-length of 391.1 metres, which is now shared by the 60-kilowatt Scottish Regional and the 70-kilowatt Burghead. Rather to my surprise, there is no sign of anything of the kind at my home in Hertfordshire. Reception of the Scottish programmes, whether in daylight or after dark, is, in fact, just what it was before the Burghead station came into operation. I daresay, though, that in other localities things are not so good. How, I wonder, are listeners faring in the neighbourhoods of, say, Perth or Fort William? Will readers in those parts tell us? It's curious how, in some places at any rate, reception is quite good from fairly distant stations which are conducting synchronous working. I notice, for instance, no wobble on 203.5 metres, where Bournemouth and Plymouth are partners, and, on 251 metres, Frankfort manages successfully to drown all signs of five smaller German stations.

In Next Week's Issue

THE NEGATIVE FEED-BACK AMPLIFIER

Quality Equipment for AC/DC Mains

HITHERTO it has been a matter of extreme difficulty to secure high quality reproduction from apparatus operating from DC supply mains owing to the low HT voltage available.



The amplifier is enclosed in an earthed metal screen to prevent any risk of shock.

This low voltage necessitates the use of pentode output valves on account of their high efficiency and the small grid bias which they require, and the drawbacks attached to the pentode are well known.

By the application of the principle of negative feed-back, which is treated elsewhere in this issue, the disadvantages of pentodes are largely removed and they acquire performance characteristics similar to those of triodes while retaining the efficiency and low grid bias of pentodes. A considerable improvement in the standard of reproduction thus follows its application.

In the Negative Feed-Back Amplifier, two pentodes are used in push-pull in the output stage, and provide a good 3 watts output. Two triode AF stages are used, so that adequate amplification is provided for the use of even insensitive types of gramophone pick-up and the more sensitive microphones. Where a sensitive pick-up is available, provision is made for connecting it after the first AF stage.

The Amplifier is self-contained and operates from AC or DC mains of from 200 volts to 250 volts.

LIST OF PARTS

2 Smoothing Chokes, 10 henrys, 210 ohms, 120 mA. — **Wearite HT11**

1 LF transformer, 1 : 3½ — **Ferranti AF5(CS)**

Condensers
- 2 1 mfd. non-inductive, 200 volts DC working — **T.C.C. 50**
- 1 0.1 mfd., tubular — **T.C.C. 250**
- 1 0.01 mfd., tubular — **T.C.C. 300**
- 2 50 mfds., 12 volts, electrolytic — **T.C.C. FT**
- 5 8 mfds., 450 volts, electrolytic — **T.C.C. 502**

Resistances

½ watt — **Dubilier F½**
- 2 100 ohms
- 1 1,000 ohms
- 1 2,000 ohms
- 2 5,000 ohms
- 1 10,000 ohms
- 2 30,000 ohms
- 2 50,000 ohms

10 watts
- 1 80 ohms — **Bulgin AR80**

1 Volume control potentiometer, tapered, 500,000 ohms — **Reliance SG**

1 Switch, SPDT — **Bulgin S81T**

4 Valve-holders, 7-pin (without terminals) — **Clix Chassis Mounting Standard Type V2**

1 Valve holder, 5-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**

1 Valve holder, 4-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**

1 3-pin plug and socket — **Belling-Lee 1119**

1 Fused mains input connector with 1 amp. fuses — **Belling-Lee 1114**

2 Lengths screened sleeving — **Goltone**

5 Ebonite shrouded terminals, E(1), PU(4) — **Belling-Lee "B"**

2 Screened connectors — **Bulgin P64**

Paxolin baseboard, 10×11×¼in. — **Micanite and Insulators**

Miscellaneous:— — **Peto-Scott or Scientific Supply Stores**

2 ozs. No. 18 tinned copper wire; 4 lengths systoflex; piece of copper foil; wood; perforated zinc cover 11×10×6½in., etc. (The Paxolin baseboard already drilled is also available.)

Screws: 8 No. 4 ¾in. c/sk; 4 No. 4 ⅜in. r/hd., 36 6BA ½in. r/hd., 2 6BA 1¼in. r/hd., all with nuts.

Valves
- 2 Pen. 3520, 2 HL1320 — **Mazda**
- 1 UR1C — **Mullard**
- 1 Barretter C2 — **Philips**

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength

(This list is included in the first issue of each month. Stations with an Aerial Power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Ankara (Turkey)	153		1961	5
Kaunas (Lithuania)	153		1961	7
Brasov (Radio Romania) (Romania)	160		1875	150
Hilversum No. 1 (Holland) (10 *kW.* till 3.40 p.m. G.M.T.)	160		1875	100
Lahti (Finland)	166		1807	150
Moscow, No. 1, RW1 (Komintern) (U.S.S.R.)	172		1744	500
Paris (Radio Paris) (France)	182		1648	80
Istanbul (Turkey)	185		1622	5
Irkutsk (U.S.S.R.)	187.5		1600	20
Deutschlandsender (Germany)	191		1571	60
Droitwich	200		1500	150
Minsk, RW10 (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	16
Motala (Sweden)	216		1389	150
Novosibirsk, RW76 (U.S.S.R.)	217.5		1379	100
Warsaw, No. 1 (Poland)	224		1339	120
Luxembourg	232		1293	150
Leningrad, No. 1 RW53 (Kolpino) (U.S.S.R.)	232		1293	100
Kalundborg (Denmark)	240		1250	60
Vienna, No. 2 (Austria)	240		1250	0.5
Tashkent, RW11 (U.S.S.R.)	256.4		1170	25
Oslo (Norway)	260		1153.8	60
Moscow, No. 2, RW49 (Stchelkovo) (U.S.S.R.)	271		1107	100
Tromsö (Norway)	282		1063.8	10
Tiflis, RW7 (U.S.S.R.)	283		1060	35
Finmark (Norway)	347		864.6	10
Rostov-on-Don, RW12 (U.S.S.R.)	355		845.1	20
Budapest, No. 2 (Hungary)	359.5		834.5	18
Sverdlovsk, RW5 (U.S.S.R.)	375		800	40
Boden (Sweden)	392		765	0.6
Banska-Bystrica (Czechoslovakia) (15 *kW.* after 5 p.m. G.M.T.)	392		765	30
Geneva (Switzerland)	401		748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	401		748	100
Ostersund (Sweden)	413.5		726	0.6
Voroneje, RW25 (U.S.S.R.)	413.5		726	10
Oulu (Finland)	431		696	1.2
Hamar (Norway)	519		578	0.7
Innsbruck (Austria)	519		578	1
Tartu (Estonia)	522		575	0.5
Ljubljana (Yugoslavia)	527		569.3	6.3
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	10
Wilno (Poland)	536		559.7	16
Budapest, No. 1 (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Athlone (Irish Free State)	565		531	60
Palermo (Italy)	565		531	3
Stuttgart (Germany)	574		522.6	100
Alpes-Grenoble, P.T.T. (France)	583		514.6	15
Madona (Latvia)	583		514.6	50
Vienna No. 1 (Austria)	592		506.8	100
Rabat (Morocco)	601		499.2	30
Sundsvall (Sweden)	601		499.2	10
Florence (Italy)	610		491.8	20
Cairo, No. 1 (Egypt)	620		483.9	20
Brussels, No. 1 (Belgium)	620		483.9	15
Lisbon (Portugal)	629		476.9	15
Tröndelag (Norway)	629		476.9	20
Prague, No. 1 (Czechoslovakia)	638		470.2	120
Lyons, P.T.T. (France)	648		463	100
Petrozavodsk (U.S.S.R.)	648		463	10
Cologne (Germany)	658		455.9	100
North Regional (Slaithwaite)	668		449.1	70
Sottens (Switzerland)	677		443.1	100
Belgrade (Yugoslavia)	686		437.3	2.5
Bodö (Norway)	686		437.3	0.5
Paris, P.T.T. (France)	695		431.7	120
Stockholm (Sweden)	704		426.1	55
Rome, No. 1 (Italy)	713		420.8	50
Kiev, RW9 (U.S.S.R.)	722		415.4	35
Kharkov, No. 1, RW20 (U.S.S.R.)	722		415.4	10
Tallinn (Estonia)	731		410.4	20
Madrid, EAJ2 (Spain)	731		410.4	3
Seville (Spain)	731		410.4	5.5
Munich (Germany)	740		405.4	100
Marseilles, P.T.T. (France)	749		400.5	90
Pori (Finland)	749		400.5	1
Katowice (Poland)	758		395.8	12
Scottish Regional (Falkirk)	767		391.1	70
North Scottish Regional (Burghead)	767		391.1	60
Stalino (U.S.S.R.)	776		386.6	10
Toulouse P.T.T. (France)	776		386.6	120
Fredrikstad (Norway)	776		386.6	1
Leipzig (Germany)	785		382.2	120
Barcelona, EAJ1 (Spain)	795		377.4	7.5
Lwow (Poland)	795		377.4	50
West Regional (Washford Cross)	804		373.1	70
Milan, No. 1 (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Moscow, No. 4, RW39 (Stalina) (U.S.S.R.)	832		360.6	100
Agen (France)	832		360.6	0.5
Berlin (Germany)	841		356.7	100
Norwegian Relay Stations	850		352.9	—
Sofia (Bulgaria)	850		352.9	1
Valencia (Spain)	850		352.9	3
Simferopol, RW52 (U.S.S.R.)	859		349.2	10
Strasbourg (France)	859		349.2	100
Poznan (Poland)	868		345.6	16
London Regional (Brookmans Park)	877		342.1	70
Linz (Austria)	886		338.6	15
Graz (Austria)	886		338.6	7.5
Helsinki (Finland)	895		335.2	10
Limoges, P.T.T. (France)	895		335.2	1.5
Hamburg (Germany)	904		331.9	100
Dniepropetrovsk (U.S.S.R.)	913		328.6	10
Toulouse (Radio Toulouse) (France)	913		328.6	60
Brno (Czechoslovakia)	922		325.4	32
Brussels, No. 2 (Belgium)	932		321.9	15
Algiers (Algeria)	941		318.8	12
Göteborg (Sweden)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Bordeaux-Sud-Ouest (France)	968		309.9	30
Odessa (U.S.S.R.)	968		309.9	10
Northern Ireland Regional (Lisburn)	977		307.1	100
Genoa (Italy)	986		304.3	10
Torun (Poland)	986		304.3	24
Hilversum No. 2 (Holland). (15 *kW.* till 3.40 p.m. G.M.T.)	995		301.5	60
Bratislava (Czechoslovakia)	1004		298.8	13.5
Midland Regional (Droitwich)	1013		296.2	70
Chernigov (U.S.S.R.)	1013		296.2	5
Barcelona, EAJ15 (Spain)	1022		293.5	3
Cracow (Poland)	1022		293.5	2
Oviedo (Spain)	1022		293.5	0.7
Königsberg No. 1 (Heilsberg) (Germany)	1031		291	100
Parede (Portugal)	1031		291	5
Leningrad, No. 2, RW70 (U.S.S.R.)	1040		288.5	10
Rennes-Bretagne (France)	1040		288.5	120
Scottish National (Falkirk)	1050		285.7	50
Bari No. 1 (Italy)	1059		283.3	20
Paris (Radio Cité) (France)	1068		280.9	0.8
Tiraspol, RW57 (U.S.S.R.)	1068		280.9	4
Bordeaux-Lafayette (France)	1077		278.6	12
Zagreb (Yugoslavia)	1086		276.2	0.7
Falun (Sweden)	1086		276.2	2
Madrid, EAJ7 (Spain)	1095		274	5
Vinnitsa (U.S.S.R.)	1095		274	10
Kuldiga (Latvia)	1104		271.7	50
Naples (Italy)	1104		271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113		269.5	11.2
Fécamp (Radio Normandie) (France)	1113		269.5	10
Alexandria, No. 1 (Egypt)	1122		267.4	0.25
Newcastle	1122		267.4	1
Nyiregyhaza (Hungary)	1122		267.4	6.25
Hörby (Sweden)	1131		265.3	10
Turin, No. 1 (Italy)	1140		263.2	7
Trieste (Italy)	1140		263.2	10
London National (Brookmans Park)	1149		261.1	20
North National (Slaithwaite)	1149		261.1	20
West National (Washford Cross)	1149		261.1	20
Kosice (Czechoslovakia)	1158		259.1	10
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark)	1176		255.1	10
Kharkov, No. 2, RW4 (U.S.S.R.)	1185		253.2	10
Nice-Corse (France)	1185		253.2	60
Frankfurt (*and Relays*) (Germany)	1195		251	25
Prague, No. 2 (Czechoslovakia)	1204		249.2	5
Lille, P.T.T. (France)	1213		247.3	60
Bologna (Radio Marconi) (Italy)	1222		245.5	50
Narvik (Norway)	1222		245.5	0.3
Gleiwitz (Germany)	1231		243.7	5
Cork (Irish Free State)	1240		241.9	1
Saarbrücken (Germany)	1249		240.2	17
Riga (Latvia)	1258		238.5	10
Rome, No. 3 (Italy)	1258		238.5	1
San Sebastian, EAJ8 (Spain)	1258		238.5	1
Nürnberg (Germany)	1267		236.8	2
Juan-les-Pins (Radio Côte d'Azur) (France)	1276		235.1	2.7
Christiansand (Norway)	1276		235.1	0.5
Stavangar (Norway)	1276		235.1	0.5
Dresden (Germany)	1285		233.5	0.25
Aberdeen	1285		233.5	1
Klagenfurt (Austria)	1294		231.8	5
Vorarlberg (Austria)	1294		231.8	5
Danzig	1303		230.2	0.5
Swedish Relay Stations	1312		228.7	—
Magyarovar (Hungary)	1321		227.1	1.25

Station.	kc/s.	Tuning Positions.	Metres.	kW.
German Relay Stations	1330		225.6	—
Montpellier, P.T.T. (France)	1339		224	1.2
Lodz (Poland)	1339		224	2
Dublin (Irish Free State)	1348		222.6	0.5
Rjukan (Norway)	1348		222.6	0.15
Salzburg (Austria)	1348		222.6	2
Tampere (Finland)	1348		222.6	0.7
Cairo No. 2 (Egypt)	1348		222.6	0.5
Königsberg (Germany)	1348		222.6	2
Nottoden (Norway)	1357		221.1	0.15
Italian Relay Stations	1357		221.1	—
L'Ile de France (France)	1366		219.6	0.7
Basle (Switzerland)	1375		218.2	0.5
Berne (Switzerland)	1375		218.2	0.5
Warsaw, No. 2 (Poland)	1384		216.8	2
Lyons (Radio Lyons) (France)	1393		215.4	25
Stara-Zagora (Bulgaria)	1402		214	2
Vaasa-Vasa (Finland)	1420		211.3	0.5
Alexandria, No. 2 (Egypt)	1429		209.9	0.5
Turku (Finland)	1429		209.9	0.5
Miskolc (Hungary)	1438		208.6	1.25
Paris (Eiffel Tower) (France)	1456		206	5
Pecs (Hungary)	1465		204.8	1.25
Antwerp (Belgium)	1465		204.8	0.1
Courtrai (Belgium)	1465		204.8	0.1
Bournemouth	1474		203.5	1
Plymouth	1474		203.5	0.3
Binche (Belgium)	1487		201.7	0.1
Chatelineau (Belgium)	1492		201.1	0.1
Wallonia (Belgium)	1492		201.1	0.1
Nimes (France)	1492		201.1	0.7
Albacete (Spain)	1492		201.1	0.2
Santiago (Spain)	1492		201.1	0.5
Liege (Radio Cointe) (Belgium)	1500		200	0.1
Verviers (Belgium)	1500		200	0.1
Pietarsaari (Finland)	1500		200	0.2
Radio Alcalá (Spain)	1500		200	0.2
Karlskrona (Sweden)	1530		196	0.2
Liepàja (Latvia)	1737		173	0.1

SHORT-WAVE STATIONS OF THE WORLD

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Ponta Delgada (Azores)	CT2AJ	4,000		75.00	0.05
Kharbarovsk (Russia)	RV15	4,273		70.20	20
Sourabaya (Java)	YDB	4,470		67.11	1
Caracas (Venezuela)	YV2RC	5,800		51.72	1
San Jose (Costa Rica)	T2GPH	5,820		51.52	1
Maracaibo (Venezuela)	YV5RMO	5,850		51.28	1
Vatican City (Vatican State)	HVJ	5,969		50.26	10
Trujillo (Domenica)	HIX	5,980		50.16	0.2
Mexico City (Mexico)	XEBT	6,000		50.00	1
Moscow (Russia)	RNE	6,000		50.00	20
Montreal (Canada)	**CFCX**	6,005		49.96	75
Havana (Cuba)	COCO	6,010		49.92	0.5
Singapore (Malaya)	ZH1	6,018		49.85	0.09
Medellin (Colombia)	HJ4ABP	6,018		49.85	1.6
Zeesen (Germany)	DJC	6,020		49.83	5
Panama City (Panama)	HP5B	6,030		49.75	0.1
Calgary (Canada)	VE9CA	6,030		49.75	0.1
Boston (U.S.A.)	W1XAL	6,040		49.67	10
Miami (U.S.A.)	W4XB	6,040		49.67	2.5
Pernambuco (Brazil)	PRA8	6,040		49.67	3
Barranquilla (Colombia)	HJ1ABG	6,042		49.65	0.15
Daventry (Gt. Britain)	GSA	6,050		49.59	15
Cincinnati (U.S.A.)	W8XAL	6,060		49.50	10
Philadelphia (U.S.A.)	W3XAU	6,060		49.50	1
Skamlebaek (Denmark)	OXY	6,060		49.50	0.5
Bogota (Colombia)	HJ3ABF	6,067		49.45	1
Vienna (Austria)	OER2	6,072		49.41	1.5
Penang (Malaya)	ZHI	6,080		49.33	0.05
Chicago (U.S.A.)	W9XAA	6,080		49.33	0.5
Nairobi (Kenya)	VQ7LO	6,083		49.31	0.5
Toronto (Canada)	CRCX	6,090		49.26	0.5
Johannesburg (South Africa)	ZTJ	6,097		49.20	5
Bound Brook (U.S.A.)	W3XAL	6,100		49.18	35
Chicago (U.S.A.)	W9XF	6,100		49.18	10
Belgrade (Yugoslavia)	....	6,100		49.18	1
Manizales (Colombia)	HJ4ABB	6,105		49.15	1
Daventry (Gt. Britain)	GSL	6,110		49.10	15
Calcutta (India)	VUC	6,110		49.10	0.5
Medellin (Colombia)	HJ4ABE	6,099		49.19	1
Wayne (U.S.A.)	W2XE	6,120		49.02	1
Havana (Cuba)	COCD	6,130		48.92	0.25
Halifax (Canada)	CJHX	6,130		48.92	0.2
Pittsburgh (U.S.A.)	W8XK	6,140		48.86	40
Winnipeg (Canada)	CJRO	6,150		48.78	2
Lisbon (Portugal)	CSL	6,150		48.78	0.51
Caracas (Venezuela)	YV3RC	6,150		48.78	1
Parede (Portugal)	CT1GO	6,198		48.40	5
Trujillo (Domenica)	HIZ	6,316		47.50	1
Caracas (Venezuela)	YV4RC	6,375		47.05	1
San Jose (Costa Rica)	TIPG	6,410		46.86	0.5
Barranquilla (Colombia)	HJ1ABB	6,447		46.52	1
Cali (Colombia)	HJ5ABD	6,490		46.21	0.1
Valencia (Colombia)	YV6RV	6,520		46.00	0.5
Riobamba (Ecuador)	PRADO	6,620		45.31	1
Guayaquil (Ecuador)	HC2RL	6,667		45.00	0.2
British Amateurs	....	7,000 to 7,300		42.86 to 41.10	0.01
Georgetown (British Guiana)	VP3MR	7,080		42.36	0.15
Tokio (Japan)	JVP	7,510		39.95	20
Prangins (Radio-Nations) (Switz'l'd)	HBP	7,797		38.48	20
Quito (Ecuador)	HCJB	8,945		[illegible]	0.25
Hong Kong (China)	ZCK3	8,750		34.29	0.5
Budapest (Hungary)	HAT4	9,125		[illegible]	5
Havana (Cuba)	COCH	9,428		[illegible]	1
Rio de Janeiro (Brazil)	PRF5	9,501		[illegible]	12
Daventry (Gt. Britain)	GSB	9,510		[illegible]	15
Melbourne (Australia)	VK3ME	9,510		31.55	1.5
Jelöy (Norway)	LKJ1	9,530		31.48	1
Schenectady (U.S.A.)	W2XAF	9,530		31.48	30
Zeesen (Germany)	DJN	9,540		31.45	50
Zeesen (Germany)	DJA	9,560		31.38	5
Bombay (India)	VUB	9,565		31.36	4.5
Millis (U.S.A.)	W1XK	9,570		31.35	10
Daventry (Gt. Britain)	GSC	9,580		31.32	15
Lyndhurst (Australia)	VK3LR	9,580		31.32	1
Buenos Aires (Argentina)	LRX	9,660		31.06	5
Philadelphia (U.S.A.)	W3XAU	9,590		31.28	1
Sydney (Australia)	VK2ME	9,590		31.28	20
Eindhoven (Holland)	PCJ	9,590		31.28	20
Prangins (Radio-Nations) (Switz'l'd)	HBL	9,595		31.27	20
Moscow (Russia)	RAN	9,600		31.25	20
Rome (Italy)	2RO	9,635		31.13	25
Lisbon (Portugal)	CT1AA	9,655		31.07	2.5
Lisbon (Portugal)	CT1CT	9,677		31.00	0.5
Madrid (Spain)	EAQ	9,860		30.43	20
Bandoeng (Java)	PMN	10,260		29.24	1.5
Ruysselede (Belgium)	ORK	10,330		29.04	9
Tokio (Japan)	JVN	10,660		28.14	20
Tokio (Japan)	JVM	10,740		27.93	20
Medellin (Colombia)	HJ4ABA	11,710		25.62	1
Winnipeg (Canada)	CJRX	11,720		25.60	2
Paris (Radio-Colonial) (France)	TPA4	11,720		25.60	12
Daventry (Gt. Britain)	GSD	11,750		25.53	15
Zeesen (Germany)	DJD	11,770		25.49	5
Boston (U.S.A.)	W1XAL	11,790		25.45	10
Rome (Italy)	2RO	11,810		25.40	25
Daventry (Gt. Britain)	GSN	11,820		25.38	15
Wayne (U.S.A.)	W2XE	11,830		25.36	1
Lisbon (Portugal)	CT1AA	11,830		25.36	2
Daventry (Gt. Britain)	GSE	11,860		25.29	15
Pittsburgh (U.S.A.)	W8XK	11,870		25.27	40
Paris (Radio-Colonial) (France)	TPA3	11,880		25.23	12
Moscow (Russia)	RW59	12,000		25.00	20
Lisbon (Portugal)	CT1CT	12,082		24.83	0.5
Reykjavik (Iceland)	TFJ	12,235		24.52	7.5
Parede (Portugal)	CT1GO	12,396		24.20	0.35
Suva (Fiji)	VPD	13,075		22.94	1
Warsaw (Poland)	SPW	13,635		22.00	10
British Amateurs	....	14,005 to 14,395		21.42 to 20.84	0.01
Vatican City (Vatican State)	HVJ	15,123		19.84	10
Daventry (Gt. Britain)	GSF	15,140		19.82	10
Daventry (Gt. Britain)	GSO	15,180		19.76	15
Zeesen (Germany)	DJB	15,200		19.74	5
Pittsburgh (U.S.A.)	W8XK	15,210		19.72	40
Eindhoven (Holland)	PCJ	15,220		19.71	20
Paris (Radio-Colonial) (France)	TPA2	15,243		19.68	12
Daventry (Gt. Britain)	GSI	15,260		19.66	10
Wayne (U.S.A.)	W2XE	15,270		19.65	1
Zeesen (Germany)	**DJQ**	15,280		19.63	50
Buenos Aires (Argentina)	LRU	15,290		19.62	5
Daventry (Gt. Britain)	GSP	15,310		19.60	15
Schenectady (U.S.A.)	W2XAD	15,330		19.57	18
Szekesfehervar (Hungary)	HAS3	15,370		19.52	20
Zeesen (Germany)	DJE	17,760		16.89	5
Wayne (U.S.A.)	W2XE	17,760		16.89	1
Huizen (Holland)	PHI	17,770		16.88	23
Bound Brook (U.S.A.)	W3XAL	17,780		16.87	35
Daventry (Gt. Britain)	GSG	17,790		16.86	10
Bandoeng (Java)	**PMA**	19,345		15.51	60
Daventry (Gt. Britain)	GSH	21,470		13.97	10
Wayne (U.S.A.)	W2XE	21,520		13.94	1
Daventry (Gt. Britain)	GSJ	21,530		13.93	10
Pittsburgh (U.S.A.)	W8XK	21,540		13.93	40

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

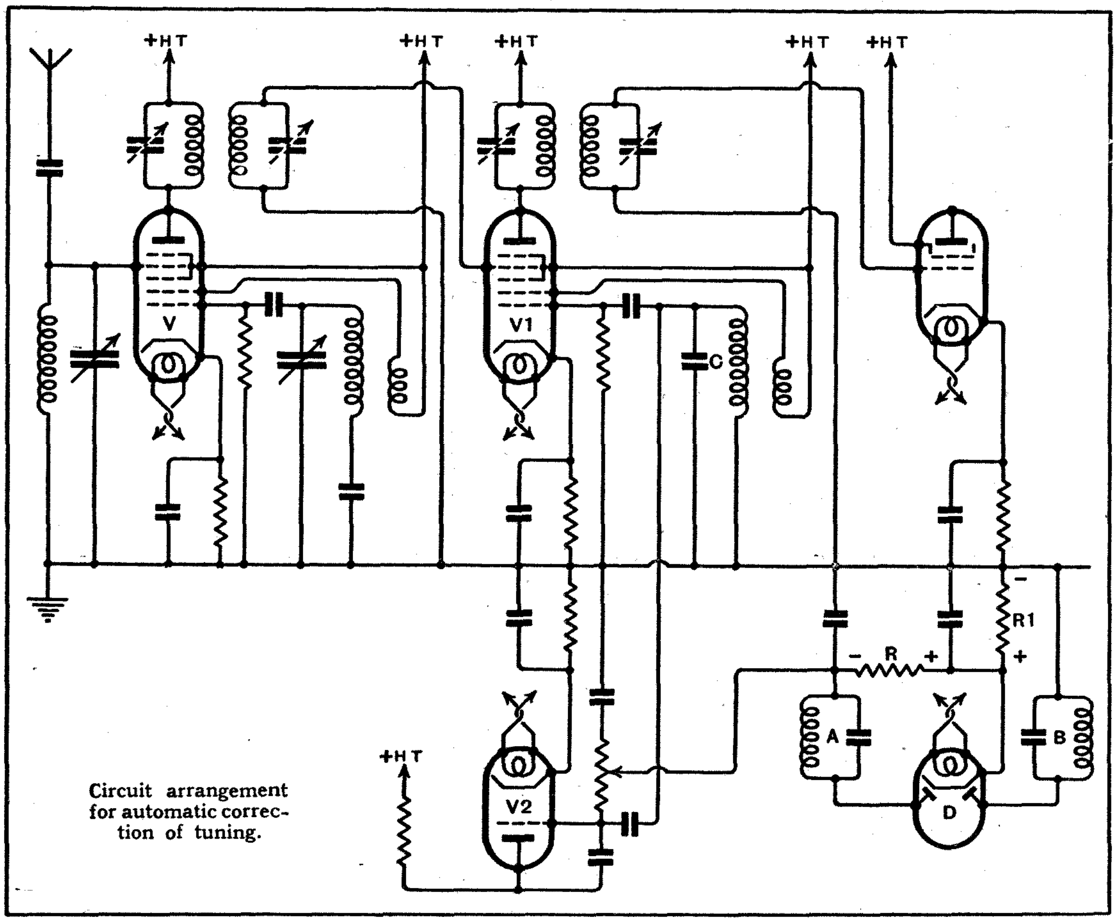
Recent Inventions

AUTOMATIC TUNING

THERE is a method for automatically correcting the tuning of a superhet set in which the "false" beat-frequency created by the mistuned circuit is utilised to vary the grid bias of a control valve. This valve is shunted across the local-oscillator circuit, and either increases or decreases its frequency until the circuits are brought correctly into tune. Such a method is, however, dependent, to some extent upon the actual wavelength which the set is receiving, and is, therefore, not equally effective at all wavelengths.

In order to remove this drawback, the ordinary superhet is replaced by a circuit in which there are two frequency-changers, so that for all wavelengths within the tuning range the second intermediate-frequency remains constant. As shown the first frequency-changer V feeds a second frequency-changer V1, the output from the latter being fed to a double-diode rectifier D. The two circuits A, B are tuned so that one is a little above and the other a little below the second intermediate frequency. Any initial mistuning thus produces a resultant EMF across the two balanced load resistances R, R1. This is applied to a control valve V2 which is shunted across the tuning condenser C of the local oscillator circuit. The consequent change in the effective grid-cathode capacity of the valve V2 provides the correcting factor which brings the set accurately into tune.

N. V. Philips Gloeilampenfabrieken. Convention date (Germany), 18th June, 1935. No. 450664.



Circuit arrangement for automatic correction of tuning.

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TRANSMISSION LINES

RELATES to installations where the aerial is located at some considerable distance from the receiver, and where both the aerial and RF circuits are tuned from a common point. In practice the intervening distance may be of the order of 300ft., which is sufficient to minimise the risk of interference by induction from supply cables and other local sources of disturbance.

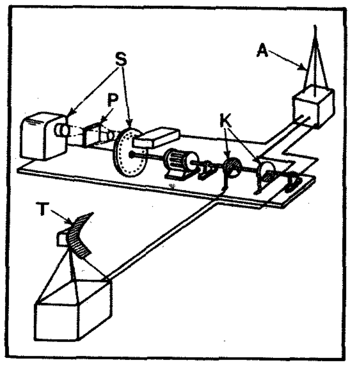
In order to ensure efficient operation under such circumstances, the aerial is coupled to the set through a high-frequency cable connected in series with a phase-changing circuit, such as a high or low pass filter, which is terminated at the receiver end by an inductance. The electrical length of the transmission line is made approximately one-half or one-quarter the received wavelength, so that the aerial is tuned by the capacity "load" thrown back by the input circuit of the receiver.

Marconi's Wireless Telegraph Co., Ltd., and N. M. Rust. Application date January 25th, 1935. No. 450520.

o o o o

"BLIND-LANDING" FOR AIRCRAFT

A RADIO installation at an aerodrome is designed to inform an approaching pilot what gliding angle he should choose, so as to land safely in fog or at night, and also to give him other necessary information by television. As shown in the Figure, short waves, say of 50 c.m., are radiated from the directional transmitter T, the beam being swung up and down through a predetermined arc so as to give alternative gliding paths, each of which is distinguished by a particular modulating signal.



Schematic layout of ground apparatus for "blind landing" of aircraft.

A second non-directional aerial A, is interlocked with the first transmitter through rotating contacts K, and transmits on a 9-metre wave, through suitable scanning apparatus S, a picture showing (a) the name of the aerodrome, and (b) the prevailing wind conditions, or any other useful information, as printed on a template P. The aeroplane carries two receivers, one for the 50-c.m. wave, and the other for the 9-metre wave, the output from both being combined on a common indicator which shows (a) the televised information, and (b) a pattern of black and white lines which identify the particular tone modulation of the beam radiated from T.

Marconi's Wireless Telegraph Co., Ltd., and R. J. Kemp. Application date January 25th, 1935. No. 450975.

o o o o

PICTURE AND SOUND RECEIVERS

THE aerial and input circuits are designed so that a single amplifier may be used to receive sound and television signals transmitted either on widely different wavelengths or on closely adjacent wavelengths. In the former case a part of the installation may be used to receive medium-wave broadcast programmes alone.

Both the sound and picture signals are heterodyned to produce intermediate frequencies which are different, though of the same order, so that they can both be fed to a common amplifier having the requisite breadth of response. Two separate aerials may be used, one earthed for normal or medium-wave working, the other being a dipole, on which both the picture and sound signals are received when transmitted on the 6-7-metre range. A single aerial may be made to serve for the whole range of reception by inserting a short-wave choke in the down-lead, so as to insulate it from the upper limb when receiving the ultra-short waves.

G. V. Dowding. Application date February 25th, 1935. No. 450263.

The British abstracts published here are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

The Wireless World

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

CONTENTS

EDITORIAL COMMENT

Technical Education

What is a Wireless Engineer ?

WITH the creation of any new industry it must always be expected that it will take some little time before any standard of technical qualifications for those engaged in the industry is established.

The wireless industry, however, seems to have been singularly unfortunate in this respect, for to-day, even after fourteen years of active broadcasting, and many more years if we include the pre-broadcasting wireless activities, we are still without any sort of definition of the qualifications of a wireless engineer and little or no attempt has been made, either by the industry or by educational bodies, to solve the problem for us.

It is true that a great many technical colleges and institutions now conduct courses in wireless engineering, and examinations can be sat for by students at the end of a course. If we study the syllabus of any one institution, however, and compare it with the syllabus of others, it will at once be apparent that there is no co-operation between the educational bodies, and no attempt made to attain uniformity in the matter either of the courses themselves or the standard of training that successful students might attain.

Finding Engineers

To-day those who desire to engage the services of a radio engineer must either be prepared to examine him themselves to ascertain what his qualifications are, or else accept him on the standard of the jobs he is already known to have carried out successfully.

From the point of view of the would-be wireless engineer, the position is even more deplorable because it is nearly impossible for him to be sure that his training will have been right for a vacancy in the industry when it comes along.

Although there are institutions carrying out conscientious work with the object of fitting men for technical positions in the radio industry and, by examination, giving them a certificate of efficiency which should be their passport to a radio engineering job, yet, because of lack of co-operation between these bodies, no sort of standardisation has been arrived at and employers have not accepted these qualifications.

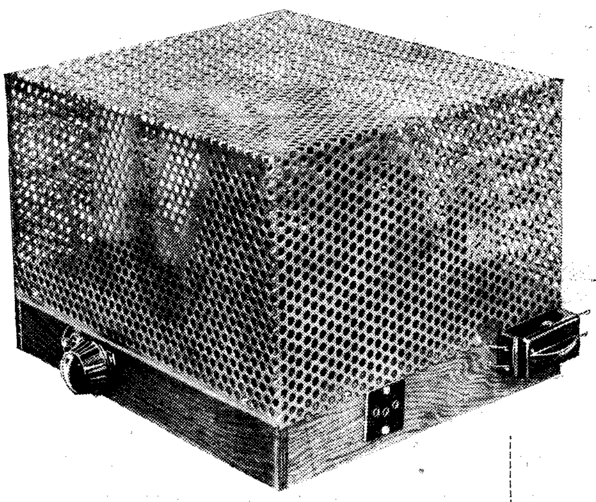
Representative Committee Needed

It seems highly desirable that some committee should be organised, consisting of outstanding technicians in the radio industry who know what qualifications they require of recruits to the industry, and representatives of educational bodies who can decide how far the educational institutions can model a syllabus to meet these requirements. The committee should also decide what examinations will guarantee that students have attained a standard of knowledge to entitle them to be styled wireless engineers. It is not necessary that one examining body only should be set up, so long as the standard is maintained.

It seems obvious that the Institution of Electrical Engineers should take a prominent part in a matter of this kind and might well be the authority to call together a representative committee. The Institution would, however, have to be prepared to modify its present attitude towards wireless engineering, In the opinion of die-hard electrical engineers at any rate, wireless is still a quite subsidiary subject, proficiency in which can be acquired by any electrical engineer at short notice.

The Wireless World Negative Feed-back

IT was shown in a recent issue of "The Wireless World" that a considerable improvement in quality of reproduction can be secured by the adoption of the principle of negative feed-back. The advantages of the system are most evident when pentodes are used, for the well-known disabilities of such valves are largely removed. In this article constructional details are given of an amplifier which embodies this principle, and which is capable of giving exceptionally fine reproduction. It is for AC/DC operation.

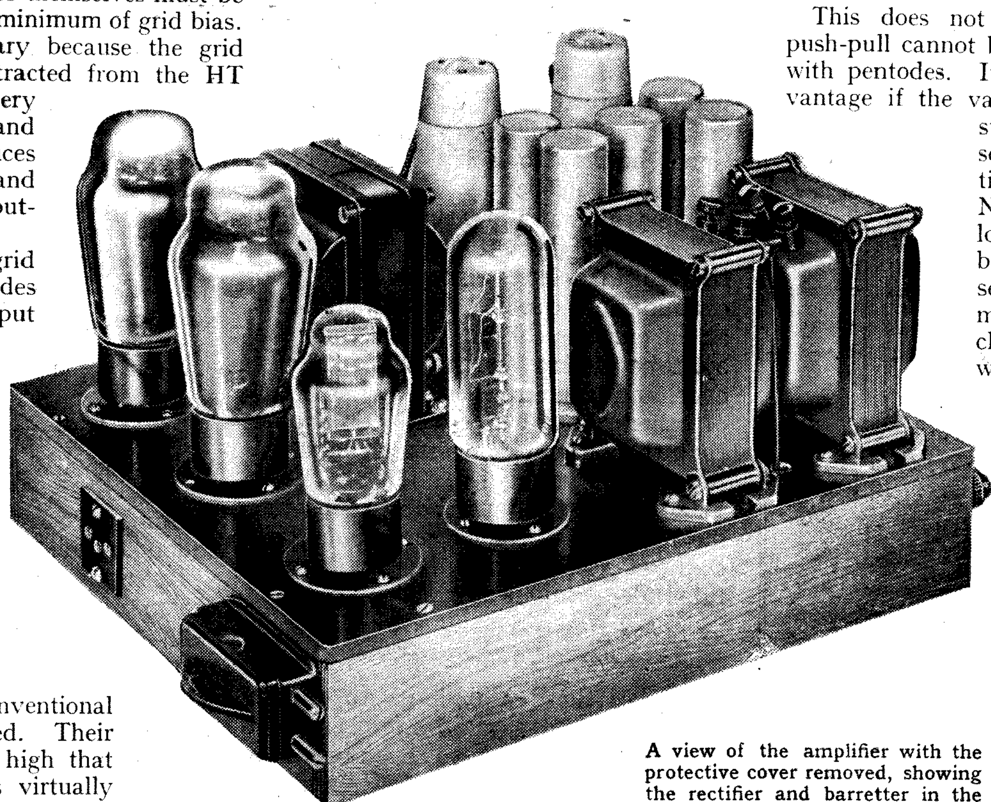


Full Details for Constructors

IN the design of equipment for operation from DC mains one is always hampered by the fact that the HT voltage is always less than the mains voltage owing to the loss in the necessary smoothing chokes. It is consequently important that as little as possible of the HT voltage should be wasted. To this end, smoothing chokes and the output transformer must be of low DC resistance, and the output valves themselves must be of types requiring a minimum of grid bias. This last is necessary because the grid bias voltage is subtracted from the HT voltage, unless battery bias is adopted, and consequently reduces the anode potential and hence the power output.

This question of grid bias normally precludes the use of triode output valves in DC mains apparatus, and one is almost forced into employing pentodes, the more so as their efficiency is higher. Pentodes, however, suffer from many defects which make it difficult to secure high-quality reproduction when the conventional circuits are employed. Their AC resistance is so high that the loud speaker is virtually undamped, thus accentuating bass resonances, and their characteristics are so shaped that a considerable degree of amplitude distortion occurs, and the optimum load impedance is quite critical.

Instead of being slightly curved throughout, as is the case with a triode, the dynamic characteristic of a pentode has a double curve rather like a much-flattened letter S. As a result the valve generates all harmonics in appreciable measure. The harmonic content in the output of a triode consists almost entirely of even harmonics with the second predominating. The distortion of a pentode, however, consists of both even and odd harmonics with the second and third predominating. Either the second or the third may be the greater, according to the value of the load impedance.



A view of the amplifier with the protective cover removed, showing the rectifier and barretter in the foreground.

When the optimum load is used, both harmonics are present in about equal degree. If the load is increased, the second harmonic falls rapidly at first to a minimum and then rises again, but the third harmonic continually increases. If the load is reduced, however, the second harmonic rises, while the third falls.

Now when we are using triodes a very considerable reduction in distortion can be made by connecting two valves in push-pull. The even harmonics then balance out and leave only the very small amount of odd harmonic distortion which occurs with triodes. With pentodes, however, the advantages of push-pull are not so great, for there is no balancing action on the third harmonic.

The Advantages of Push-pull

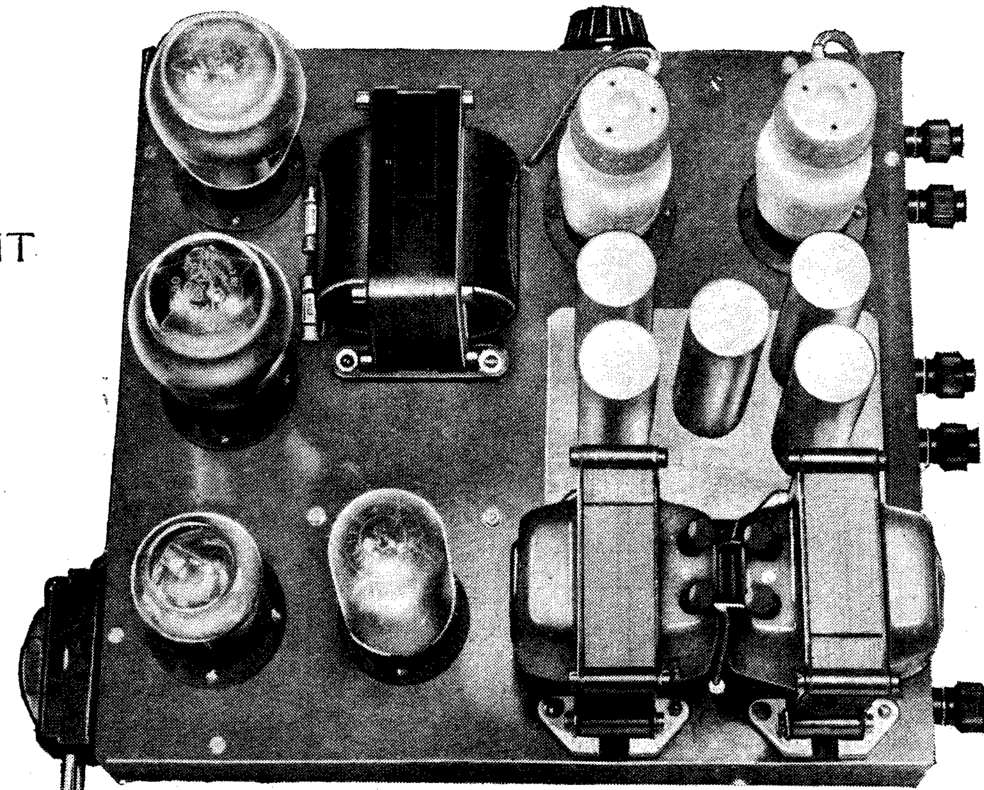
This does not mean, however, that push-pull cannot be made beneficial even with pentodes. It is certainly of no advantage if the valves are operated with such a load that the second harmonic distortion is in any case small. Normally, however, the load is chosen for the best compromise between second and third harmonic distortion. It is clear, therefore, that if we use push-pull and so obtain a condition in which we can ignore the second harmonics, we can reduce the load impedance to the value giving a minimum of third harmonic distortion.

When using triodes it is usually assumed that the optimum load for a push-pull stage is twice that for a single valve. This is certainly untrue with pentodes, however, and the optimum for a pair of well-matched valves is of the same order as that for a single valve. It is unwise to proceed to extremes, for valves are not always well matched, and

Amplifier

HIGH QUALITY EQUIPMENT FOR AC-DC MAINS

By W. T. COCKING



In this view of the amplifier the sheet of copper foil upon which the electrolytic condensers are mounted can clearly be seen.

in practice a load of about 1½ times that of one valve offers a good compromise.

Apart from permitting some increase in output, push-pull is of advantage in regard to the output transformer. With a DC set two output valves are in any case necessary for good volume, and each may consume 40 mA. or so. If the valves are in parallel the current through the output transformer is 80 mA., and a large core is essential if saturation of the iron is to be avoided. The transformer thus becomes costly and bulky. With push-pull, however, the steady anode currents balance out in their effect on the core, and the design of the output transformer is much easier.

It can be seen, therefore, that the output stage of a DC mains amplifier designed for good volume at high quality would contain two pentodes in push-pull operated with a load impedance of the order of 1½ times the optimum for one valve. If the performance is to be comparable with that of an AC amplifier embodying triodes, however, something more is needed, for the third harmonic distortion is still rather high, and the output impedance of the amplifier is much too high to damp the loud speaker properly.

This something more is to be found in the application of the principle of negative feed-back, due to H. S. Black, of the Bell Telephone Laboratories. For some considerable time this system has been used in communication engineering, and its application to broadcast receivers was discussed rather fully in last week's issue of *The Wireless World*. It is sufficient to say here, therefore, that it operates by feeding a portion of the output voltage back to the input in such phase that it opposes the input voltage. The gain is reduced, but amplitude distortion is also reduced in about the same proportion, the effective output impedance is greatly lowered, the frequency response characteristic is improved, and the operation is much less affected by small changes in

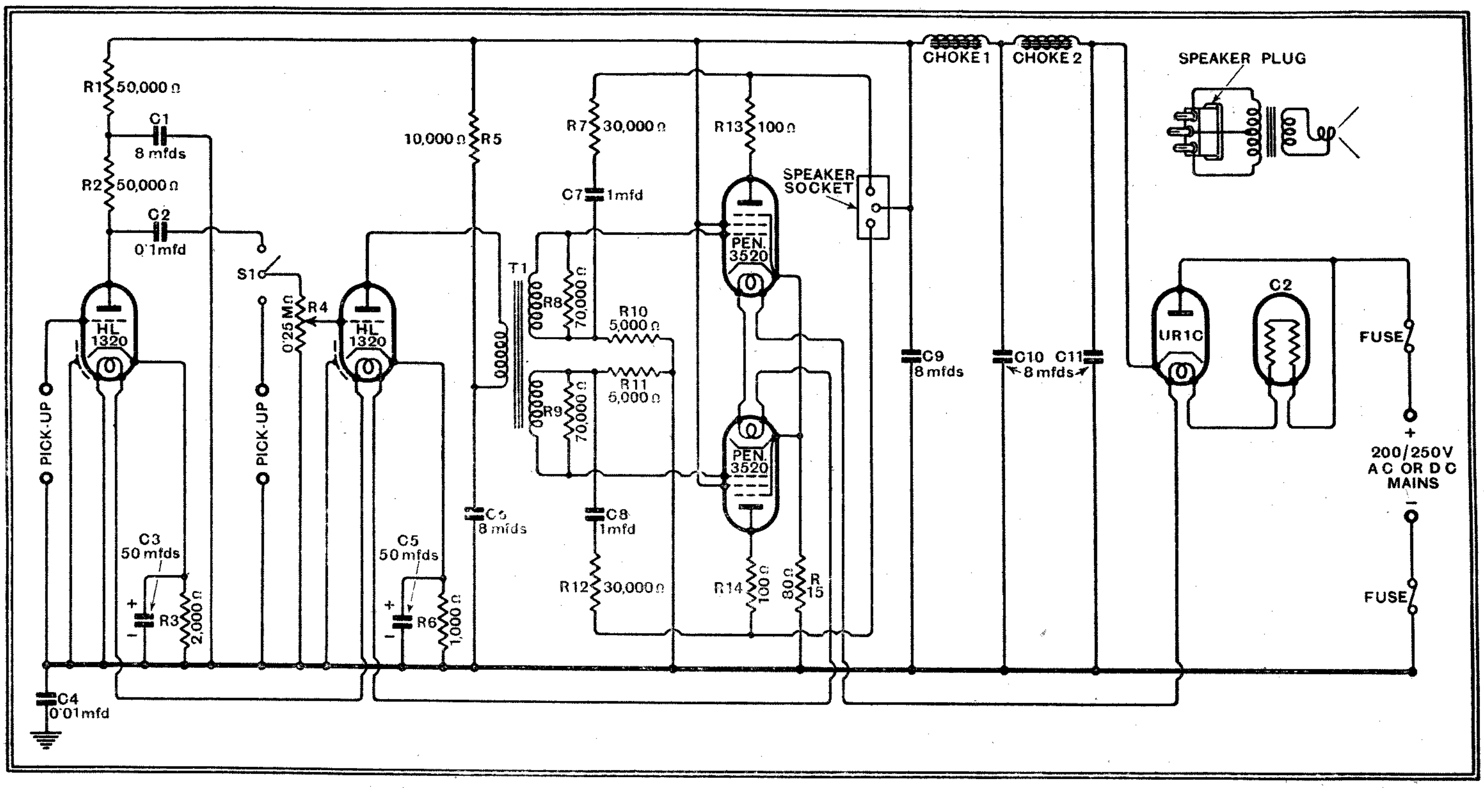
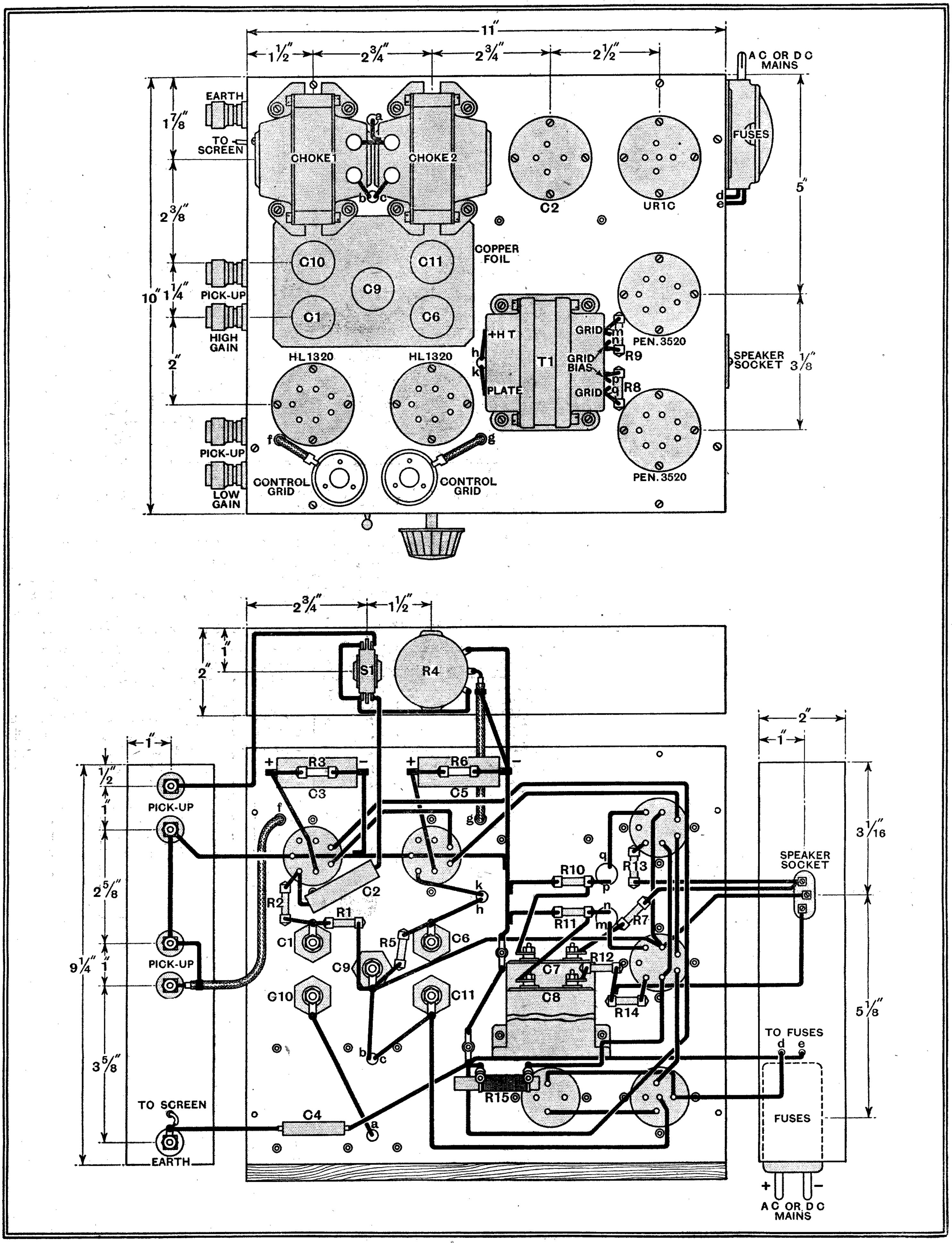


Fig. 1.—The complete circuit diagram of the amplifier. Negative feed-back is secured through the action of R7, C7, R10, R12, C8, and R11.

PLAN FOR ASSEMBLY AND WIRING UP



Complete details of the construction and wiring of the amplifier are given in these drawings.

Negative Feed-back Amplifier—
valves, component values, and operating voltages.

It is found that when the amount of feed-back is such that a pentode has an apparent output resistance similar to that of a triode, it requires about the same input voltage. In many respects, therefore, the application of negative feed-back has the effect of giving triode characteristics to a pentode, but the stage retains the low grid bias and comparatively high efficiency of the pentode. The advantages are considerable, and the disadvantage is merely the loss of the high sensitivity of the pentode.

The complete circuit diagram of an amplifier embodying this principle is shown in Fig. 1, and it will be seen that two Pen.3521 valves are used in push-pull in the output stage and operated with an anode-to-anode load impedance of some 6,000 ohms. Resistances R13 and R14 of 100 ohms each are included in the anode circuit to prevent parasitic oscillation, and grid bias is derived from the 80-ohm cathode resistance R15.

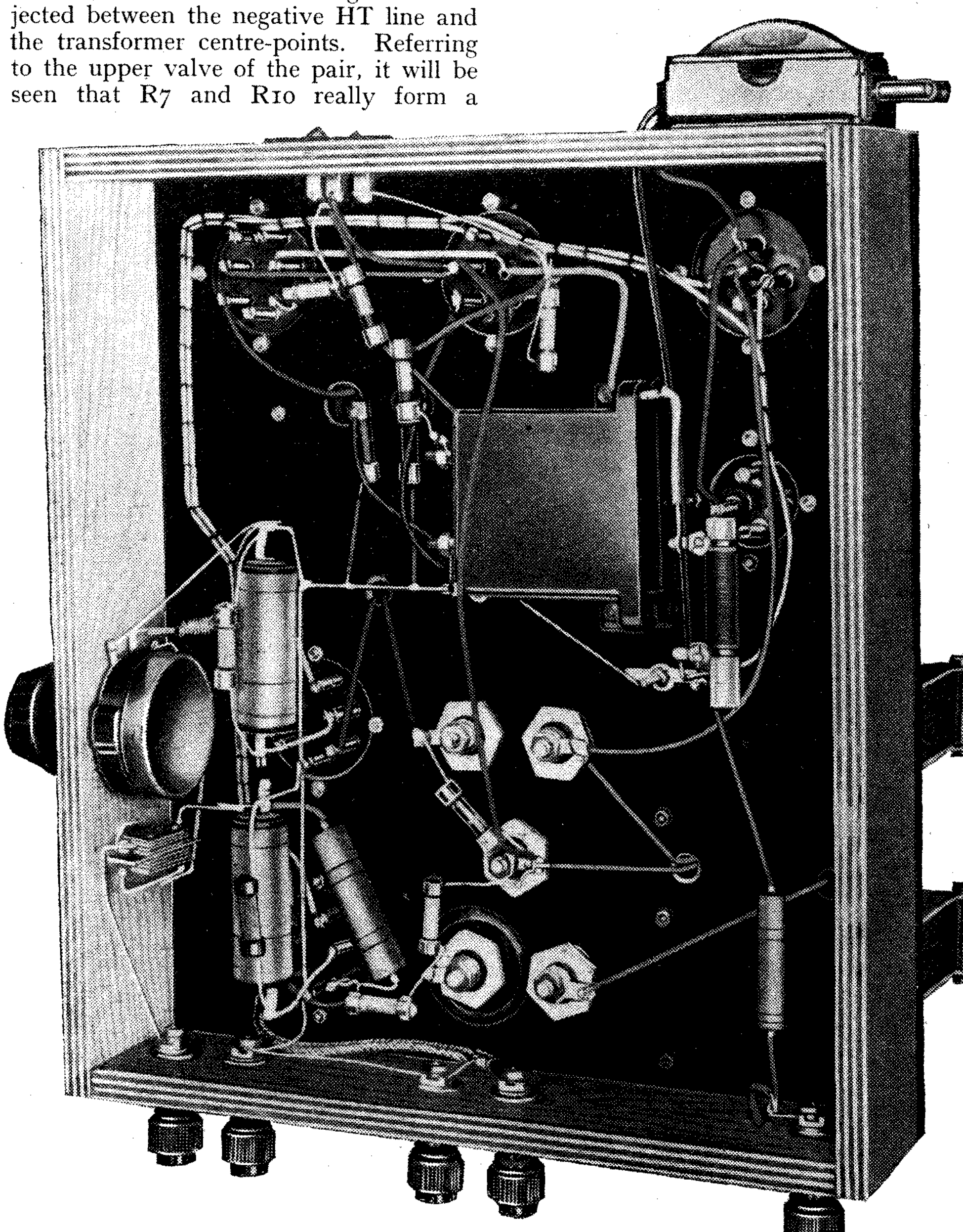
A full-size blue print of the wiring diagram is available from the Publishers, Dorset House, Stamford Street, London, S.E.1. Price 1s. 6d. post free.

The input is derived from a transformer having a split secondary; this is important, and the fed-back voltages are injected between the negative HT line and the transformer centre-points. Referring to the upper valve of the pair, it will be seen that R7 and R10 really form a potentiometer across the output of this valve, for C7 is included only to prevent the HT from being short-circuited. The total value of R7 and R10 is 35,000 ohms, and R10 is 5,000 ohms, so that one-seventh of the output is fed back to the input. In the second output valve the action is the same, but the feed-back network is R12, C8, and R11.

The frequency discrimination in the feed-back network itself is negligible over the audible range of frequencies. The fed-back voltages, however, must pass through the transformer secondaries to reach the grids of the valves, and it is found that this introduces a phase-change at high frequencies. This causes an increased high-frequency response to be secured, and in one case at 10,000 c/s the response rose to about + 14 db! In order to avoid this effect, therefore, each half-secondary is shunted by a 70,000 ohms resistance; this artifice enables a very good characteristic to be secured.

The preceding stages follow standard practice. The penultimate valve is a triode decoupled by the 10,000-ohm resistance R5 and 8-mfd. condenser C6, and biased by the 1,000-ohm resistance R6, which is shunted by a 50-mfd. condenser C5. A 0.25-megohm volume control R4 is included in the grid circuit, and when the switch S1 is in the lower position (on the circuit) one pair of PU terminals is joined directly to it.

A fairly large input is then needed for full output, and it is recommended that this pair of terminals be used only for a sensitive pick-up, such as a piezo-electric type, or for the output from a radio set. For less sensitive pick-ups, including the needle-armature type, and fairly sensitive microphones, an additional stage of amplification is included. S1 is then in the



The details of the underside of the amplifier are clearly shown in this illustration.

LIST OF PARTS

2 Smoothing Chokes, 10 henrys, 210 ohms, 120 mA. **Ch1, Ch2** — **Wearite HT11**

1 LF transformer, 1 : 3½ — **Ferranti AF5(CS)**

Condensers
- 2 1 mfd. non-inductive, 200 volts DC working, **C7, C8** — **T.C.C. 50**
- 1 0.1 mfd., tubular, **C2** — **T.C.C. 250**
- 1 0.01 mfd., tubular, **C4** — **T.C.C. 300**
- 2 50 mfds., 12 volts, electrolytic, **C3, C5** — **T.C.C. FT**
- 5 8 mfds., 450 volts, electrolytic **C1, C6, C9, C10, C11** — **T.C.C. 502**

Resistances
- **½ watt** — **Dubilier F½**
- 2 100 ohms, **R13, R14**
- 1 10,000 ohms, **R5**
- 1 1,000 ohms, **R6**
- 2 30,000 ohms, **R7, R12**
- 1 2,000 ohms, **R3**
- 2 50,000 ohms, **R1, R2**
- 2 5,000 ohms, **R10, R11**
- 2 70,000 ohms, **R8, R9**
- **10 watts**
- 1 80 ohms, **R15** — **Bulgin AR80**

1 Volume control potentiometer, tapered, 500,000 ohms, **R4** — **Reliance SG**

1 Switch, SPDT, **S1** — **Bulgin S81T**

4 Valve holders, 7-pin (without terminals) — **Clix Chassis Mounting Standard Type V2**

1 Valve holder, 5-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**

1 Valve holder, 4-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**

1 3-pin plug and socket — **Belling-Lee 1119**

1 Fused mains input connector with 1 amp. fuses — **Belling-Lee 1114**

2 Lengths screened sleeving — **Goltone**

5 Ebonite shrouded terminals, E(1), PU(4) — **Belling-Lee "B"**

2 Screened connectors — **Bulgin P64**

Paxolin baseboard, 10×11×¼in. — **Micanite and Insulators**

Miscellaneous:—
Peto-Scott or Scientific Supply Stores
2 ozs. No. 18 tinned copper wire; 4 lengths systoflex; piece of copper foil; wood; perforated zinc cover 11×10×6½in., etc. (The Paxolin baseboard already drilled is also available.)
Screws: 8 No. 4 ¾in. c/sk; 4 No. 4 ⅜in. r/hd., 36 6BA ½in. r/hd., 2 6BA 1¼in. r/hd., all with nuts.

Valves
- 2 Pen. 3520, 2 HL1320 — **Mazda**
- 1 UR1C — **Mullard**
- 1 Barretter C2 — **Philips**

Negative Feed-back Amplifier—
upper position, and the first and second valves are resistance-coupled in a conventional manner.

Some surprise may be felt that the bias resistance of the first valve has a value twice that of the second, while the valves are of the same type, and the first has actually a lower anode voltage than the second. The reason is that, because of the lower anode voltage, the current is lower, and a higher resistance is needed to develop the necessary bias voltage.

No volume control is connected before the first valve, since overloading will not occur in normal use. A large input should not be applied to this valve, however. The second pair of input terminals should always be used if adequate output can be secured.

It may be remarked at this point that if no external circuit is connected to the first pair of terminals, they should be short-circuited to prevent the valve from running with an open grid circuit. In cases where apparatus is being continually connected and disconnected, however, it would be a wise plan to wire a 1-megohm resistance across these terminals.

The Mains Equipment

Two smoothing chokes are employed in conjunction with 8-mfd. electrolytic condensers, and a half-wave rectifier is used to permit operation on AC supplies. The heaters are all wired in series, and a barretter is used to regulate the current.

In AC/DC apparatus it must never be forgotten that the circuits are live to the mains, and that precautions must be taken to prevent the possibility of shock. The components are accordingly mounted on a Paxolin chassis, and the whole of the upper deck is covered by a cage of perforated zinc which is earthed. In one corner there is a little clearance between this cage and the smoothing chokes, so to prevent any risk of a short-circuit a piece of fibre, or even thick cardboard, should be slipped between.

The external pick-up connections are also important. Screened leads must be used to avoid hum pick-up, but they cannot be earthed. If they are to be effective in preventing hum, they must be connected to negative HT. It is, therefore, necessary to use insulated screened cable. Such cable, having a single internal wire for the high potential connection and metal braided screening, can be obtained with an overall insulation from J. Dyson & Co. (Works), Ltd. The screen is used for the low potential pick-up lead, and is naturally connected to the input terminal, which is joined to negative HT.

A pick-up having a metal frame will also have to be maintained at negative HT potential if hum is to be avoided. It would be unsafe to connect it directly to this point, however. Fortunately, it will suffice to connect it directly to the screen of the connecting cable through a 0.001-mfd. condenser rated for 250 volts AC working.

On test, the apparatus fully justified all expectations. Mains hum proved inaudible on all the DC and AC supplies upon which it was tested, the amplification proved adequate, and the frequency response almost perfect. Amplitude distortion was also found to be abnormally low, and in every respect the reproduction was of the kind hitherto only associated with high-quality AC equipment. The undistorted output obtainable naturally varies with the mains voltage, being greatest with 250 volts AC and least with 200 volts DC. On 230 volts DC an output of about 3 watts can be secured, and appreciably more on peaks without noticeable distortion.

For AC/DC use a permanent-magnet type loud speaker is recommended, for if an energised model be used it will be necessary to provide it with a rectifier and smoothing equipment. If the gear is to be operated from DC only, however, an energised type is quite suitable.

On the Short Waves

NOTES FROM A LISTENER'S LOG

IT has been known for a long time that the highest ionisation levels normally experienced are to be found on the "midday route" from London to South Africa as far as short-wave transmission from this country is concerned.

It is, of course, over this highly ionised route that the very consistent day-in and day-out 28 Mc/s (10 m.) signals have been received from the well-known amateur transmitter ZS1H in Cape Town.

Letters which I have received from Africa also state that the Empire station, GSH, is not as strong at midday as it is during the afternoon, when it reaches an R8/9 signal, so that evidently even this high frequency of 21.47 Mc/s (13.97 m.) is noticeably attenuated during the noon period.

It is not surprising, therefore, to hear that good reception of the 11 a.m. tests which were radiated during October from Alexandra Palace has been reported from Johannesburg.

This report refers to the sound transmissions on 41.5 Mc/s (7.2 m.), and the receiver used in this case was a straight three-valve set, the signals received being apparently quite intelligible.

It is interesting to note, however, that so far no report has been received dealing with reception of the vision signals from Alexandra Palace, and it is therefore just possible that the higher carrier frequency used in this case, namely, 45 Mc/s (6.8 m.), is just above the critical frequency, whilst the sound on a slightly lower frequency is bent and succeeds in covering the 5,000 miles to South Africa.

As television transmissions are now taking place during daylight, viz., between 3 and 4 p.m., it will be interesting to see whether it will still be possible to receive the sound transmissions in South Africa. Actually, this change in timing may mean that the centre for optimum long-distance reception of these transmissions may move from South Africa to South America.

It should be borne in mind, however, that this 40 Mc/s "dx" reception is likely to be considerably more erratic than long-distance reception on 28 Mc/s or 10 metres.

My own first "dx" 40 Mc/s (7 m.) reception was over the South American daylight route, when several years ago now I managed to pick up the half-wave of LSL on 42.32 Mc/s (7.1 m.).

Reception during the past fortnight has definitely drifted towards winter conditions, and by 11 p.m. on most nights the 15 Mc/s (19 m.) band has become quite dead.

Earlier in the evenings, however, W2XAD has been a star performer, with W2XE on 21.52 Mc/s (13.94 m.) outperforming W3XAL in the afternoons. Incidentally, W2XE has been an improved signal on all frequencies recently, though he still shows a tendency to overmodulate at times.

On the 9 Mc/s band (31 m.) W1XK has been putting up a rather better performance than the stronger W2XAF, generally because the former station has a much clearer channel, W2XAF being troubled at times with two heterodynes, from LKJ1 and from an unknown South American.

In this band, the afternoon broadcasts from VK3LR have been fairly well heard on occasion, as have also the test transmissions from Tokio JZI on 9.35 Mc/s. This station, also, has interfered with W2XAF at times.

As far as Tokio is concerned, however, the best reception has been on JZK on 15.17 Mc/s.

One cannot help but comment, too, on the way in which the 7 Mc/s amateur band is transformed every evening into a miniature broadcasting band, and from the transmitters operating in it, some of them using English, all shades of Spanish opinion may be gathered.

Latin-American Reception

In other bands, too, the Spanish language is beginning to dominate, and recently the tendency to winter conditions has brought in a whole "crop" of Latin-American stations at good strength in the 9 and 6 Mc/s regions.

Few of these stations last year had any programme value at all, but to-day a number of them, especially the Cuban ones, may be received clearly with reasonable quality on the loud speaker, but since mostly recordings are broadcast, the entertainment value still remains relatively low.

The occasional excellent reception from W2XAF, such as during the evening of November 1st, has, however, been the only really bright spot for late listening recently.

For the benefit of those listeners who may be interested, the receiver shown in the title illustration accompanying my last notes has three bands and covers from 18 Mc/s to 550 kc/s—two HF stages being provided before the frequency-changer on the highest-frequency band.

The U/SW converter shown on the right extends the range of the receiver down to 5 metres; the converter itself actually tunes from 60-15 Mc/s (5-20 m.) without coil-changing.

ETHACOMBER.

The General Overhaul

REMOVING THE CAUSES OF POOR RECEPTION

By

JAMES GIBBONS

THE writer, a service man of wide experience, describes the procedure that he adopts when dealing with a broadcast receiver that is suffering, not from any obvious defect, but from a general falling-off in performance.

WHEN a receiver begins to show a general falling-off in liveliness, it will almost always be found that the decline is due to many contributory defects rather than to a single major fault. Obviously, the defects must be dealt with one by one, and the writer proposes to describe the procedure that he himself has adopted with success.

The first thing to do is to remove the chassis from the cabinet, connect up, and allow the set to attain normal working temperature, meanwhile removing the inevitable dust. As soon as the valves are thoroughly warm, a careful test of general performance should be made. If one is familiar with the set under test, so much the better; if not, an opinion based on experience of sets with similar circuit specification must be formed.

A run up the medium waveband can be very informative, the weaker Regionals being a good check for sensitivity. If careful note is made of the calibration, much useful information can be obtained about the state of alignment of the IF amplifier, and whether or not the oscillator circuits are tracking correctly with the input circuits. For instance, if the calibration is accurate at the bottom end of the medium waveband, out in the centre, but tolerably good at the top, it is pretty safe to assume that the IF amplifier is out of gang. On the other hand, if the calibration is correct at the bottom end but goes progressively out towards the top end, the medium-wave padding condenser is just as likely to be the cause of the trouble. With regard to the foregoing it should be mentioned that the majority of British broadcast superhets use the shaped-vane system of oscillator tracking on the medium waveband and therefore a medium-wave padding condenser is not used.

Switch Adjustments

A thorough check should now be made on the various switches, particularly the wave-change switch, which is still one of the most troublesome components in a wireless receiver, and in numerous sets is placed in an absurdly inaccessible position.

The trouble with wave-change switches is always the same; either the contacts are dirty and/or out of adjustment, or else the switch makes correct contact but is noisy in operation. The cure is pretty obvious; the first thing is to clean all the contacts and then to so adjust them that they all open and close together. It is the writer's experience that the first operation is best done by the application of a piece of extremely fine glass paper dipped in petrol and applied between the contacts with the aid of a pair of pliers with a to-and-fro motion. The actual adjustment is best done with a switch adjusting tool; E.M.I. Service sells a very good one at the reasonable price of 2s. 9d. Wave-change switches always have to be treated according to their individual merits (if any). Some are quite easy to adjust, but the majority are pretty difficult. However, the above method has been used with great success on all types.

The volume control and the various fixed resistors should now be given a look-over; noise and intermittent working are the defects to look for here. The composition volume controls now favoured by radio manufacturers can give no end of trouble when they become defective, causing "fading," intermittent signals and sometimes even bad distortion, this latter effect usually arising when the volume control also acts as the signal diode load resistance—an arrangement which is practically universal in recent receivers. It is strongly recommended that this component be renewed at the first sign of unreliability.

Fixed resistors are more reliable these days than they were a few years ago. The writer distinctly remembers one well-known mains superhet whose whole history could be summed up in the words "resistor trouble." If the set went "off" you could wager that a resistor had gone "dis." and cut off the HT from somewhere. If distortion developed, the potential divider supplying grid bias to the output valve had changed in value. If "double humped" tuning developed, you just changed the resistors across which the AVC voltage was developed; those fitted had a nasty habit of changing to about twice their value. If the set developed "whistles," some resistor had collapsed and caused the IF amplifier to oscillate and so on. It got to be quite an automatic process, but, in fairness to all, let it be said that this manufacturer made his own resistors. However, they are pretty good these days. I suppose it was one of those "technical hitches."

Noisy Resistors

Tapping a resistor with the wooden handle of a screwdriver will often produce audible evidence in the speaker if the resistor is inclined to "go intermittent" or so become noisy. Wire-wound ones seem to be the worst offenders and they usually develop a very dry and discoloured appearance when nearing the end of their useful life. Doubtful-looking ones should always be renewed. This helps to reduce the possibility of some of those intermittent faults developing which are apt to try the patience and resource of the service man nearly to breaking point. Electrolytic condensers should be removed from the chassis and thoroughly cleaned, particularly round the base, as any contact resistances here reduces the effective capacity of the condenser. The various connections and joints in the set should be examined and any doubtful-looking ones resoldered.

Finally, the set should be switched on, allowed to warm up and then measurements taken of the various HT voltages and anode current values of the valves, at the same time noting their freedom or

The General Overhaul—
otherwise from noise by tapping the glass envelopes with a few inches of thick rubber tubing or other suitable tool. Care should be exercised not to tap them too hard. The writer knows of several valves that have been tapped out of existence in this way. New valves should be fitted where the previous tests show them to be necessary.

If, by a rather high noise-to-signal ratio and inaccurate calibration, the set shows signs of being out-of-gang, it should be retrimmed throughout. The apparatus required is a calibrated modulated oscillator capable of supplying a signal at all the required frequencies, and an output indicating device which may well be an AC voltmeter reading either 0-5 volts or 0-150 volts full scale. Another requirement is the actual trimming tool. Some engineers use an ordinary thin-bladed screwdriver with insulated handle and the blade covered with a piece of systoflex, others make a special tool for the job or buy one ready made. Quite a good one can be made from a discarded fountain pen by scrapping the writing nib and inserting in its place about 1 inch of screwdriver blade, which should be insulated up to the tip with a short length of systoflex. The chassis should be arranged so that the IF trimmers are readily accessible.

Trimming the IF Amplifier

Before the actual trimming operation is started, ¼-megohm resistances should be soldered or clipped across the primary and secondary of the IF transformer about to be adjusted. These are necessary to ensure that the IF amplifier has the correct response curve after alignment. If the output meter is an 0-5 volt type it should be connected across the secondary of the output transformer, if of the 0-150 volt type, connect it across the primary but interpose an 0.1 mfd. condenser between the meter and one side of the primary winding, this, of course, to prevent a DC voltage being applied to the meter. With the resistors in place, and the output meter connected, it remains now to connect the oscillator and carry on with the job. The test oscillator should be adjusted to the correct intermediate frequency and the output connected between the grid of the last IF valve and chassis. Where AVC is incorporated in the receiver under adjustment it is of vital importance to keep the output signal from the oscillator as low as possible. This precaution is, of course, necessary to prevent the AVC circuit from varying the sensitivity of the IF amplifier while it is being adjusted, with consequent masking of the optimum condition. A good plan is to adjust the test signal to a point where there is a fair amount of set noise present. It may then be considered about right. The secondary trimmer of the IF transformer should be adjusted first, and then the primary trimmer, after which the resistors should be connected across the next transformer (moving along towards the first detector) and the output of the oscillator transferred to the previous IF valve or first detector as the case may be. The trimmers are naturally adjusted for maximum output as indicated by the output meter, and as the IF transformers are brought more and more into correct alignment, it may become necessary to reduce the output of the oscillator to the required value.

When the serviceman is confident that the IF amplifier is correctly trimmed, attention may then be devoted to adjustment of the oscillator and RF circuits. This is done by first switching the set to the medium waveband and connecting the oscillator to the aerial and earth sockets. A test signal (not too strong) should be injected into the receiver at about 250 metres and the dial reading of the set altered if necessary to this wavelength. If the previous calibration of the set was incorrect, this slight alteration in the tuning position will certainly cause a reduction in the reading of the output meter, but this is quite in order.

The next operation is to adjust the oscillator condenser trimmer for maximum output. When performing this operation it is usual to find that there are two distinct positions of the oscillator condenser trimmer for greatest output, one when screwed up tight and the other when screwed up to a much lesser degree. It is this latter position which is the correct one. When quite sure about the oscillator circuit, the RF circuits can be trimmed, and then the ganging process is complete as far as the medium waveband is concerned. Some receivers have a separate set of trimmers for the long waveband. When overhauling a set of this type the above process has to be gone over again with the set switched to the long waveband, and the test oscillator arranged to inject a signal at 1,000 metres. The long-wave circuits are adjusted in the same order as before, i.e., oscillator circuit, and then RF circuits.

Checking AVC Action

The foregoing remarks on trimming are very brief and general. Wherever it is possible to consult the makers' service manual, it should always be done prior to the alignment, and the instructions found therein followed to the letter. It is unlikely that anything of a revolutionary character will be learned, but naturally the experience of continually handling the same sets develops a technique which obtains best results with a minimum of adjustment and in the shortest time. For instance, some makers recommend that the primaries and secondaries and/or different transformers in the IF amplifier be adjusted to slightly different frequencies to obtain the correct response curve without the help of ¼-meg. resistors. While the test oscillator is connected to the aerial and earth terminals, it is a good plan to check the AVC action by noting the output meter reading when the test signal is varied in strength between a very low and a high value. If the AVC action is in order, the meter reading will remain sensibly constant, falling only when the test signal is attenuated to a very low value. Another way is to insert a milliammeter in the anode circuits of the controlled valves and to note the variations in anode current for different strengths of test signals. By now the performance of the receiver should be quite up to standard for its type, and a short test should be given on broadcasting so that any odd resonance effects may be detected.

CLUB NEWS

The West London Radio Society

A very interesting lecture and demonstration on a 16-valve American receiver was recently given by Mr. Douglas Walters. Meetings of the society are held every Wednesday at the "Anchor," 94, Uxbridge Road, W. Ealing, London, W.13. Full details concerning the activities of the society can be had from the Hon Sec., at 22, Cambourne Avenue, W. Ealing, W.13.

The Wirral Amateur Transmitting and Short-wave Club

At a meeting held at the King's Square Café, Birkenhead, Mr. G. Bramwell (G2RF) gave a lecture on 5-metre transmission and reception. On Wednesday, November 25th, there will be a junk sale. Full details of the club's activities can be had from the Hon. Sec., at "Caldy," Irby Road, Heswall, Cheshire.

The Croydon Amateur Radio Society

An interesting lecture was recently given by Mr. B. R. Betteridge of the Marconiphone Co., on the subject of ultra-short-wave reception and the stringent precautions that are necessary when designing receivers for this part of the spectrum. On a subsequent evening amateurs brought their gramophone pick-ups to the meeting and an instructive time was had in conducting comparative tests in connection with an amplifier and the appropriate measuring instruments. The club holds its meetings in St. Peter's Hall, Ledbury Road, S. Croydon, At the next meeting on Tuesday, November 17th, at 8 p.m., six short talks will be given by individual members of the club. Full particulars of the society can be obtained from Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

The Bradford Experimental Radio Society

On Tuesday next, November 17th, a lecture will be given by Mr. B. R. Betteridge, of the Marconiphone Co. Full particulars of the society can be obtained from the Hon. Sec., at 23, Baslow Grove, Heaton, Bradford.

The North Manchester Radio Society

The above society holds meetings on alternate Fridays at 8 p.m. at the British Legion headquarters in Elm Street, Bury New Road, Whitefield, near Manchester, where all enthusiasts are welcome. Full particulars of the society's activities can be obtained from the Hon. Sec., at 10, Dalton Avenue, Thatch Leach Lane, Whitefield, near Manchester.

The Leeds and District Radio Society

The above society has been formed to cater for the needs of all classes of radio enthusiasts. Headquarters have been established in Azelea Street, Beckett Street, Leeds, 9, and meetings are held every Monday at 7 p.m. Those interested are invited to communicate with Mr. J. Kavanagh, the Hon. Secretary, at 63, Dawlish Avenue, Leeds, 9.

"Airadios"

TELEGRAMS WHICH LINK EARTH AND SKY

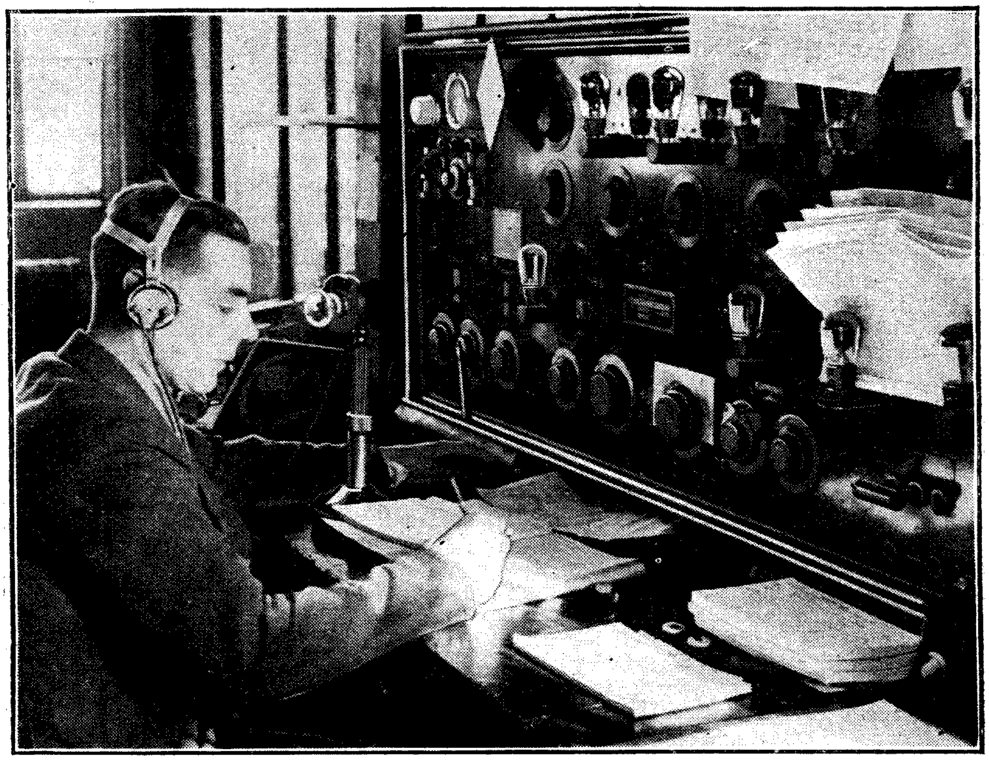
Flight Photo.

PASSENGERS by sea have for many years been linked by wireless to the International Telegraphic System; the aviation wireless service, formerly restricted to meteorological and navigational messages, has now been extended to provide similar facilities for travellers by air.

THE wonderful wireless system which has been developed on the long-distance airways, and which permits the exchange of constant messages between air-liners in flight and ground-stations, also enables a facility to be placed at the disposal of the air-travelling public of which an ever-increasing use is now being made.

This is the ability of any member of the public on the ground to send a radio-telegram to any friend, relative, or business associate who may—at the particular time any urgent message becomes necessary—be up in the air in one of the big aircraft which maintain our regular flying services between England and various parts of the Empire.

The facility of wireless communication for members of the public between air-liners in flight and ground stations has, for the sake of convenience, been given the short, descriptive title of "airadio." This word appears as the heading on message forms employed in connection with the service by airway ground stations and by air-liners in flight.



Flight Photo.

Reception of messages at the Croydon Airport radio station.

There are, it should be mentioned, still certain limitations in regard to the service as it is in operation between Imperial Airways' air-liners and ground-stations. The facility cannot, for example, be made available in connection with aircraft operating on European routes, although Italy has now accorded permission for airadios to be sent from aircraft through Italian ground-stations to any country. As to the Empire air-routes, there is a restriction in connection with the operation of the service in India. This is to the effect that, while air-liners are operating over India, messages can only be sent from aircraft to the ground, and only for places in India and Burma.

To illustrate the operation of this airadio service between earth and air one may take, first of all, the case of a message originating at some point on the ground, and intended for delivery to a passenger who is in flight. Such a radio-telegram is accepted in the usual way at any telegraph office. Then the position is ascertained of the air-liner carrying the passenger for whom the airadio is intended. When this has been done, the message is not transmitted direct from the originating point to the air-liner in flight, but from the office of origin to whatever ground station happens, at the moment, to be nearest to the point where the air-liner is actually in flight. This then calls the air-liner. When communication has been established, the message is transmitted to the wireless operator of the air-liner, who writes it out on one of the forms provided for the purpose, and duly delivers it to the passenger.

R.M.A.: Royal Mail Aircraft

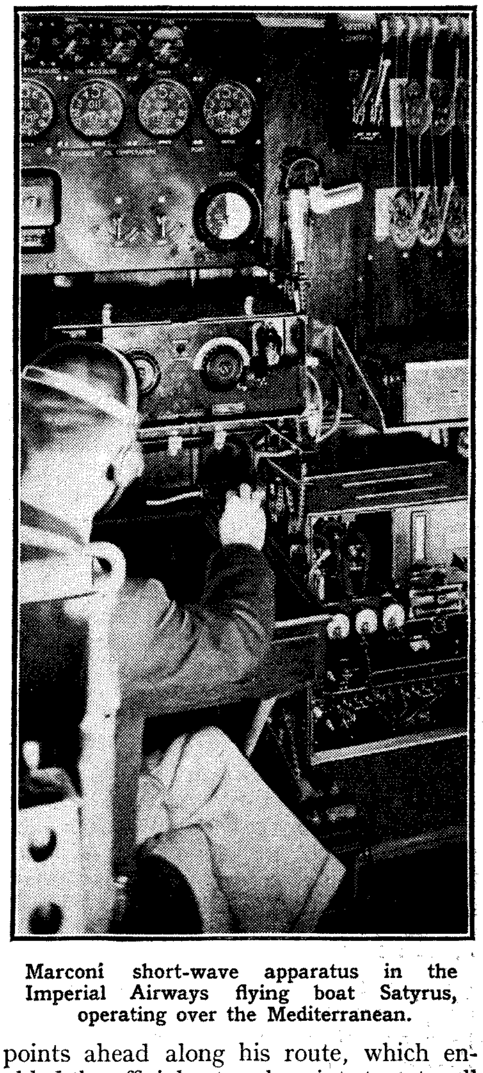
By the reverse process, a passenger in an air-liner hands his message to the radio operator, who then establishes wireless communication with whatever ground station happens to be nearest at the moment. From the ground station the message is sent to its destination as an ordinary telegram by the appropriate route—radio, cable, or land-line.

Radiograms from an air-liner in flight to any ground-station bear the name of the aircraft of origin in the same way as those emanating from a liner at sea, but bear the letters "R.M.A."—which, of course, stand for the identifying words "Royal Mail Aircraft"—followed by the name of the aircraft: for example, "R.M.A. Hannibal," "R.M.A. Hengist," etc.

The ability of those on the ground to keep constantly in touch by radio with some passenger who is making an air

Airadios—

voyage often proves of the greatest value to all concerned. Among the examples forthcoming one can take the case of a prominent Government official who, not long ago, was making an official tour by air along some of the main Empire routes. It was necessary to make appointments for him to see local officials at the various points where he was alighting. It was also necessary to confirm whether he could find time to attend the many functions and ceremonies that were proposed. All queries concerning such matters, and also relating to other urgent official business, were flashed from various ground-stations to the air-liner, being duly received and studied by the official to whom they were directed. He in his turn, while still up in the air, was able to study carefully the whole itinerary of his flight, and to make up his mind what new appointments he could fit into his schedule, and what minor engagements it would be impossible for him to fulfill. Then, while still sitting comfortably in his air-liner armchair, with all necessary papers before him, he was able to write messages of instruction, for



Marconi short-wave apparatus in the Imperial Airways flying boat Satyrus, operating over the Mediterranean.

points ahead along his route, which enabled the officials at such points to get well forward with their local preparations, and to have everything cut-and-dried, long before the air-liner carrying their visitor hove in sight to make its landing.

Passengers take the keenest interest in the operation of the airadio service. It seems a very romantic thing to them that, even while they are high in the air over some jungle, forest, or sea, they should be able to flash personal messages to friends down on the earth in far-off cities. One of the wireless operators flying on the India route was recalling the other day the fact that, during the celebrations in connection with the Jubilee of the late King George, a party of air-liner passengers got together while the machine was flying down the Persian Gulf, and dispatched to His Majesty a combined message of greeting from the air. On another occasion, while an air-liner was flying high above the desert not far from Baghdad, an airadio was received which gave the result of the Derby within only a few minutes of the finish.

When the first passenger planes began flying between London and the Continent, in the summer of 1919, there was no wireless communication at all between these machines in flight and the ground-stations; while even the wireless transmission of weather reports was in a very rudimentary stage. But since those days progress has been rapid, and there now exists a network of ground-stations covering Europe and stretching southward across Africa and eastward to India and beyond; with the result that to-day, even while in flight over thousands of miles of Empire routes, and while high above trackless deserts or primeval forests, the big air-liners are always in touch by wireless with one or other of the ground-stations.

RANDOM RADIATIONS

By "DIALLIST"

D-X Doctoring

ON the high seas it is no uncommon thing for the wireless officer to pass on to a doctor on some other vessel or ashore a call for medical aid. But on land diagnosis and treatment by wireless are comparatively rare. The other day an operator at Edmonton in Canada heard weak distress signals in morse. On getting into touch he found that they emanated from a tent nearly 1,000 miles away in the Arctic Circle. A young miner tapped out that his 24-year-old mate was dying and called for help. The miner was told to stand by for telephony and within a few minutes he heard the voice of a doctor asking him to describe the trouble. Though he could receive telephony, he could transmit in morse only and his replies to the doctor's questions were sent in dots and dashes. The illness was diagnosed; simple treatment was prescribed and immediate steps were taken to send help by aeroplane.

No Chance for the Set

IT'S really amazing to find how many people will put down the money for a good set—and then proceed to get the worst out of it. On the evening before these notes were written I went to see some friends who had installed their first receiver some weeks previously, paying quite a big price for it, as prices go nowadays. Yet, there was the thing snuffling and wheezing away in its corner and sounding like something that would be dear at a couple of pounds. I went across to see what very distant foreign station could be coming in; for by the hissing and other background noises it seemed to be a transmission of small power hundreds of miles away. It was the local national at a range of 15 miles and the volume control was full on! They had found that the set "worked" without aerial and earth, so they had decided that these were unnecessary. Results: No foreign stations, though this set is capable of bringing in dozens, and nothing but the poorest possible reception of the local regional and national.

A Common Error

This is, of course, rather an uncommon kind of instance. Most people, however small their knowledge of wireless, do provide the set with some kind of aerial and earth. But I've no doubt at all that amongst your friends you know one or two who are giving good sets no real chance of showing what they can accomplish. Many people believe that the modern set is so sensitive that any kind of aerial will do. And so it will—up to a point. With a yard or two of wire attached to the aerial terminal you can quite likely get several home stations and a good many foreigners. But you don't receive them as they ought to be received. Noisiness is too much in evidence on all stations, and in the more distant ones the automatic volume control has no chance of taking charge of even slight fading. AVC can be effective only if there is a big reserve of amplification to be brought into use when signal strength wanes. There is no such reserve when the hand volume control is at or near the maximum position. Modern sets do deserve first-rate aerials; unfortunately it is not always that they get them.

Up and Up

WITH an increase of 44,704 during September in the radio licence figures the total amounted at the end of that month to 7,786,920. This is 213,080 short of the eight million mark, but as October, November and December are always months when big increases take place it seems still possible that we may reach it by the end of the year. If we do it will be an amazing achievement, for it will mean that two-thirds of the homes in this country have licensed wireless sets. The actual number of receivers in action is, of course, very much in excess of the licence figures, since so many people have two or more sets in different rooms, whilst others use "fixed" sets at home and take portables with them in their journeyings afield. Then there are the "pirates." No one knows what their numbers are, but they may easily run to 100,000 or more. The Post Office people, by means of detector vans and in other ways, continue to rope them in in fair numbers—and probably this will always be so.

Interesting Figures

It's rather interesting to look at the September licence figures in detail and to see what is going on in different parts of the country. London shows an increase of 2,508, and the English counties one of 35,267. Scottish figures are up by 4,665 (Burghhead should soon make a big difference), and those for Northern Ireland by 1,649. But for Wales the total expansion is only 615. Only one county in England, Scotland or Northern Ireland shows a decrease. This is Monmouth, with a falling off of thirty-one since the previous month. The Welsh border and Wales itself are the places where increases are smallest or actual decreases most common. Flintshire is down by twelve and Glamorganshire by nineteen. The biggest increase for any Welsh county is 165 for Caernarvonshire. In Cardiff licences fell away by 411, and in Bridgend by 166. Poor reception conditions locally may account for most of the shrinkages.

The Wired Relay Position

AS I predicted, the recommendations of the Ullswater report have had the effect of bringing the development of wired relays almost to a standstill for the time being. After pointing out that the present licences of relay companies expire at the end of this year, and that "the licences include express provision that on their termination the Postmaster-General may require the licensee to sell him such portions of the plant and apparatus as he may specify at a price 'equal to the value thereof at the date of purchase as plant and apparatus *in situ*, exclusive of any allowance or compensation for loss of profit, compulsory sale, goodwill, the cost of raising capital or any other consideration,'" the report recommended that the G.P.O. should acquire the relays and the B.B.C. be responsible for their programmes. I believe that in the end it will be a good thing for the Post Office to take them over; but in the meantime, with their future uncertain and with the prospect of receiving little or nothing for any improvements that they may make, it is not surprising that the relay companies are holding their hands. The chairman of one big concern stated the other day that the policy of his company would be to take on as many new subscribers as existing apparatus could deal with, but to keep down capital expenditure.

The Ullswater report was published in February, and now, *nine months later*, the relay position is still almost as nebulous as ever. This is not good enough. Wired relays do very useful service in areas where interference is severe, or where it is difficult with ordinary apparatus to obtain good direct reception of the home programmes. Surely the soundest policy would have been for the G.P.O. to carry out thorough inspections of apparatus and wiring, and, where these were approved, to encourage development, with an undertaking to give full compensation if and when the companies were bought out. The Post Office should aim at taking over at a fair price a vigorous, going concern—the more vigorous and the more "going," the better the G.P.O.'s prospects of making a real success of it. Any policy that hampers progress is bad. There is nothing to be said, in any event, for marking time for all these months.

A Novelty for Set Makers

HERE'S an idea that I present free, gratis and for nothing to makers of wireless sets. For flats and for the small living rooms of modern houses corner cupboards, corner shelves, and so on, are very popular, and you haven't to do much thinking to see the reason. Then why not a wireless receiver in a corner cabinet? There may be such, though, if there are, they're not well known, and certainly I've not come across them. There would be no difficulty about making up a set on a triangular chassis. The only thing is that you couldn't slip it in or out from the back. The front of the cabinet would therefore have to be made so that it was easily detachable. Not much difficulty about that; think of the lightning manner in which the piano tuner gets at the works of your piano. The corner cabinet should be pretty good from the acoustic point of view, for the walls would throw the sound well into the room. Perhaps one of *The Wireless World's* expert designers will bear the corner set in mind when he is thinking out his next receiver for the home constructor.

TELEVISION PROGRAMMES

The principal items only of each day's programmes are given. The system to be used each day is given below the date. Transmission times are from 3-4 and 9-10 p.m. daily.

Vision 6.67 m. (45 Mc/s). Sound 7.23 m. (41.5 Mc/s).

FRIDAY, NOVEMBER 13th.
(Marconi-E.M.I.)

3.5, Film: "Television Comes to London." **3.20,** British Movietone News. **3.35,** Excerpts from Albert Coates' new opera "Mr. Pickwick" prior to staging at Covent Garden.

9.5, Film short. **9.15,** Talk on the Declining Population by John Hilton, illustrated by charts, etc. **9.30,** British Movietone News. **9.45,** Jacqueline in Songs at the Piano.

SATURDAY, NOVEMBER 14th.
(Marconi-E.M.I.)

3.5, Veteran Car Rally. **3.30,** British Movietone News. **3.45,** Dancing Time: Retta Ray and Doray and Chela (Cuban dancers).

9.5, B.B.C. Film. **9.25,** Cabaret.

MONDAY, NOVEMBER 16th.
(Baird.)

3.5, Film. **3.15,** Movietone Magic Carpets: Fisherman's Fortune. **3.20,** Picture Page.

9.5, Movietone Magic Carpets: Land of the Nile. **9.15,** Film. **9.30,** Picture Page.

TUESDAY, NOVEMBER 17th.
(Baird.)

3.5, Examples from the Exhibition of Inn Signs. **3.25,** Film. **3.40,** Starlight: Leonard Henry.

9.5, Inn Signs. **9.25,** Film. **9.40,** Irene Prador (cabaret artist).

WEDNESDAY, NOVEMBER 18th.
(Baird).

3.5, Modern Galleries: Pottery and Sculpture. **3.20,** Film. **3.35,** London Characters: Robert Hale and W. J. Smith (whistling guard). **3.50,** Movietone Magic Carpets: Land of the Nile.

9.5, Modern Galleries. **9.20,** Movietone Magic Carpets: Fisherman's Fortune. **9.35,** London Characters: Rosina Dixon (singing cook) and Jack O'Brien (a ganger). **9.50,** Film.

THURSDAY, NOVEMBER 19th.
(Baird.)

3.5, The Mask Theatre. **3.20,** Film. **3.30,** Wireless Transmitter Valves: Construction described by Leslie Mitchell. **3.50,** Nina Devitt (cabaret artist).

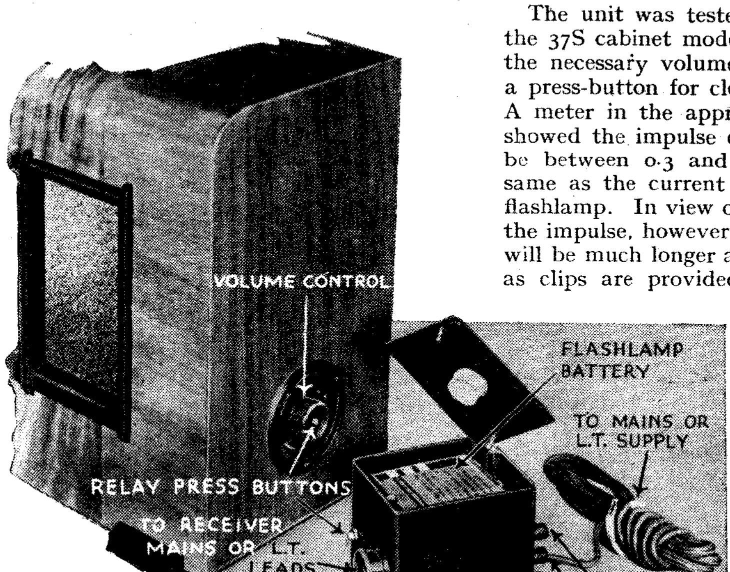
9.5, Repetition of 3.5–3.50 programme. **9.50,** Suzanne McClay (cabaret artist).

The W.B. "Long Arm"

THE purpose of this component is to enable the set to be switched on or off from the extension loud speaker. It is designed for use with the Stentorian 37S, 37J and "Cadet" speakers and incorporates a rocker type relay which alternately makes and breaks contact for successive impulses. The current for operating the relay is derived from a standard 4½-volt flashlamp battery housed in a compartment immediately below the lid of the moulded case.

All that is necessary when installing is to transfer the existing mains plug to the leads supplied with the unit and the receiver leads to the small plug at the side. This serves to put the relay contacts in series with the mains. Three-way flex is necessary for the extension leads to the loud speaker, but it should be noted that these do not carry any mains current.

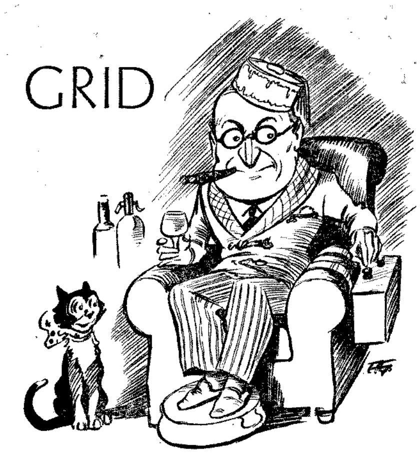
The unit was tested in conjunction with the 37S cabinet model, which is fitted with the necessary volume control incorporating a press-button for closing the relay circuit. A meter in the appropriate extension lead showed the impulse current to the relay to be between 0.3 and 0.4 amp.—about the same as the current taken by the average flashlamp. In view of the short duration of the impulse, however, the life of the battery will be much longer and it is easily renewed as clips are provided to take the contact strips.



"Long Arm" remote control unit with a W.B. Stentorian speaker showing the auxiliary controls.

The volume control is well graded and the relay was found to be positive and reliable. Incidentally, a press-button is provided on the unit itself so that the set can also be controlled from this point if desired. The "Long Arm" is equally applicable to mains and battery receivers and the price is 15s. 6d.

UNBIASED By FREE GRID



Listening in comfort.

Armchair Control at Last

I SUPPOSE that one of the biggest curses of wireless is the fact that you have to keep on jumping up out of your fireside armchair to change from one station to another. This is, of course, to a large extent the fault of the B.B.C. which, instead of doing the sensible thing and sticking all the worth-while items on one station and all the dud stuff on the other, insists on mixing them all up so that it is necessary for listeners to keep on doing the Jack-in-the-box stunt that I have mentioned.

To the uninitiated the obvious solution would be to have the set drawn up close to your armchair, and so, indeed, it might be if the set manufacturers would separate receiver and loud speaker, but as things are, the arrangement is only suited to the partially deaf, who don't mind the loud speaker bellowing in their ear all the time. Actually, this scheme of a separate loud speaker is not all it might seem, however, as you can prove by silencing the built-in loud speaker and using an extension one at the other end of the room. The trouble-causers in this particular case, as they so often are in others, are the women of the household, who seem to dislike what they call the untidiness of a set standing beside the armchair.

Although I have been searching for more years than I care to think upon, I have so far failed to come across a scheme which is free from snags, and I have, therefore, been reluctantly forced to produce the necessary device myself, and I am happy to say that my invention is sufficiently far advanced to enable me to give you the details, although I have not yet actually gone into production with it.

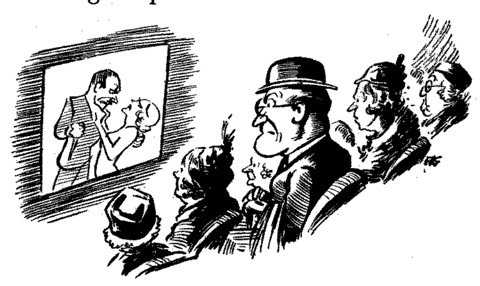
The device, like most great inventions, is really very simple. Needless to say, it operates by wireless and thus does away with the necessity for trailing connecting wires and other archaic and cumbersome arrangements. You will probably all know of the so-called self-tuning circuit which is used on a well-known commercial set. With this scheme it is only necessary to tune a receiver approximately to the wavelength of a station, and it will then at once proceed to adjust itself accurately. This is the basis of my invention, and my receiver is being fitted with it. Hanging on to the arm of my chair is a completely self-contained miniature transmitter covering the broadcast wavelengths. Since the range required of it is only a few feet, its aerial is also self-contained and its power is purely nominal.

Now when I desire to change the programme all I have to do is to switch on my transmitter, which consists of a very simple single-valve oscillator arrangement, and turn the tuning control until I am within a few kilocycles of the wavelength which the receiver happens to be tuned to at the moment. Owing to the fact that my transmitter is so much closer to the receiver than is the broadcast station to which it is tuned, my carrier wave is by far the more powerful of the two, with the result that the receiver immediately adjusts itself to my wavelength. Meanwhile, of course, I keep moving my tuning control very slowly round, and, naturally, the self-tuning arrangement of the receiver follows like Mary's little lamb —or, to be more exact, it *will* do so as soon as I have made the device up. I finally halt on the wavelength of the station to which I desire to listen, and, naturally, the receiver settles itself there also, and I promptly switch off, leaving the self-tuning arrangement of the receiver "held" by the carrier wave of the distant broadcasting station.

A Shady Ruse

NOW that the regular television programmes have started it is possible for Londoners to get a free look-in at quite a number of places, but I must confess that it is a source of astonishment to me to find that most—I do not say all—of these places are in the suburbs. I should have thought that *all* large departmental stores in the centre of London would have done something about it instead of leaving it to their fellow money-snatchers out in the wilds.

I have been very busy during the past few days going the rounds of the various places where television is on show, more especially those in the suburbs, and consequently I am now in a far better position to appreciate the feelings of the author of "In Darkest England" when he was moved to write that astonishing work. I could, did I choose to do so, add an illuminating chapter or two to it.



Thrilling drama of love and hate.

While commending the enterprise of the managers of certain of these stores, I must confess that in one particular case I am wondering whether it was not a little overdone, and, in my opinion, the manager is skating on very thin ice. Having slipped a life preserver and a pair of knuckledusters into my pocket one afternoon, I set out for a certain part of outer London where I had been told a show was being given. I descended from the train at the station nearest my destination, and, securing a trustworthy local guide, I made him understand by signs where I wanted to go.

Having duly arrived at my destination and seated myself among a motley collection of natives, I prepared to enjoy the show, and was soon engrossed in a thrilling drama of love and hate coming from the Alexandra Palace. I sat through, and thoroughly enjoyed, a large number of varied items, but was astonished to find that several of these were nothing more nor less than thinly disguised boosts for the products of some of our great national advertisers.

I should probably have been sitting there still had not the pangs of hunger caused me to glance at my watch when, to my amazement, I found that I had been there no less than three hours. Naturally, since I knew that the B.B.C.'s programmes were only of one hour's duration, the scales fell from my eyes with a resounding clatter—or at least, I thought they did. In high dudgeon I at once sought out the manager, and pointing to one of his posters in which he invited the public to come into his wretched shop and see the B.B.C. television programmes, I asked whether he had anything to say before I handed him over to the police, because it was obvious that we had been looking at a miniature cinema show.

To my surprise he had a good deal to say, and stoutly averred that I *had* seen the B.B.C. programme, and that it was the actual television programme and not even a cinematographic record of it which was being shown. Further explanations revealed the fact that we had really and truly witnessed the Alexandra Palace show, but that immediately on the conclusion of it we had, without any explanation, been gently faded over to ordinary home cinema films projected on to the back of the same translucent screen. The manager pointed out that he had shown the public the B.B.C. television show exactly as on the posters, and surely, he added, he could not be blamed if, out of the generosity of his heart, he gave them overweight and chucked in a cinema show as well. All the same, the whole affair has left a nasty taste in my mouth.

BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

Christmas Broadcasting

MEMORIES of King George V will crowd upon us on Christmas afternoon if only because the familiar "Round the Empire" broadcast, culminating in the warm and homely greeting by the late King, will be acutely missed.

The period normally devoted to the Empire broadcast will this year be filled by gramophone records. A concert by the Hastings Municipal Orchestra will follow.

"King Arthur" and a Party

In many ways, it seems, Christmas broadcasting will be just as festive as ever. It is understood that Mr. Eric Maschwitz, Variety Director, intends to hold his annual party in the Concert Hall at Broadcasting House. Who the "guests" will be is not yet settled; but listeners can count upon a merry gathering, presented in such a way that all who tune-in can imagine themselves present.

Another big feature on Christmas Day will probably be a broadcast of Rutland Boughton's fantasy opera, "King Arthur," with the London Symphony Orchestra.

Empire Programme for the Regionals

On Boxing Day Regional listeners will be asked to participate in the Empire Christmas Party as transmitted from Daventry.

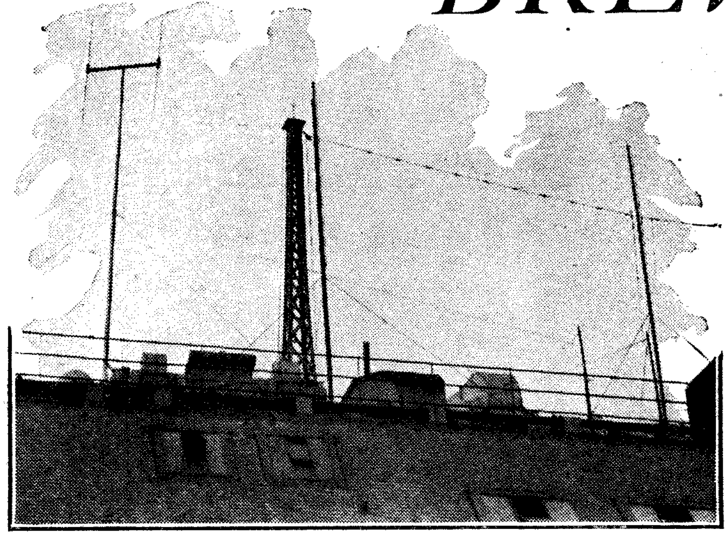
Two regular broadcasts of the Christmas season—the relay of carols from King's College Chapel, Cambridge, and also from St. Mary's, Whitechapel—are again included.

The first of the Christmas broadcasts will be a Pageant of Pantomime on December 22nd.

Wanted: Yarns of the Navy

EX-NAVY men, wireless and otherwise, may be able to help Mungo Dewar in his search for material for the next "Eight Bells" broadcast, the fourth edition of which is scheduled for January of next year. A huge mail quickly followed the last broadcast; piles of correspondence came from Portsmouth, Glasgow, Belfast, and other coastal towns, and even from the fishing fleet lying at Yarmouth and Lowestoft. The writers, all of whom were eulogistic, were mostly inspired by the amusing incidents which figured in "Eight Bells," and many of them offered equally funny yarns for future use.

Mungo Dewar is still collecting naval stories; so if you know a good one send it in.



ONE MORE MAST has been added to the forest which is springing up on the roof of Broadcasting House. This picture, taken by a *Wireless World* photographer, from the roof of a nearby building, shows just a few of them, including on the left the latest addition, a half-wave dipole with reflector for television reception. There are nine aerials in all, one being for ultra-short-wave experimental transmission and the other for reception. Three of these are used for checking reception in the control room.

Televising Wireless Valves

EVERY *Wireless World* reader should buy, beg, borrow, or steal an opportunity to see the television transmission on Thursday next (November 19th) at 3.30 or 9.30, when wireless transmitter valves are to be shown and their functioning described. Some of the manufacturing processes will also be demonstrated, and there will be a commentary by Leslie Mitchell.

An Unrehearsed Ceremony

AN eye-witness account from the studio at Alexandra Palace during the two inaugural ceremonies last week would dwell on the amazing precision with which the whole affair was worked out. Although "stand-ins" had gone through the ceremony beforehand, the principals had had no rehearsal whatever. A breakdown of any kind, a mishandling of cues, or even a minor delay on such an occasion might have had a temporarily damaging effect on the cause of television. Fortunately, not the slightest hitch occurred.

Split-Second Schedule

Some idea of the complexity of the business can be had if we remember that, in the Baird transmission, both the spotlight and the intermediate film systems were in use. Leslie Mitchell's announcement in the spotlight studio had to be timed to the split second. Before he was halfway through it, Mr. R. C. Norman had begun his introductory speech before the intermediate film camera, which, working with a time lag of between 50 and 60 seconds, offered the first portion of processed film to the scanning frame a moment or two after Mr. Mitchell's announcement was completed. An overlap would have spelt catastrophe.

Broadcasting Election Results

ELECTION time means a frenzied time for any broadcast organisation, and the B.B.C. staff have accordingly cast a sympathetic eye across the Atlantic to their cousins handling the Presidential Election broadcasts over there.

The N.B.C. networks employed a staff of more than fifty persons at the New York headquarters working exclusively on the election returns. They included "ace" announcers trained to declare the most shattering polling results without a tremor of partisanship in their well-modulated voices; "re-write" men who held it "a sin to tell a lie"; computors whose figures have never yet been challenged; and a host of engineers whose duties ranged from gain control operation to hiking through the streets with button-hole mikes to pick up crowd reactions.

And now it is all over for another four years.

Gliders and Ultra-shorts

THE gliding broadcast to-morrow (Saturday) from Dunstable Downs will be slightly less ambitious than had been hoped. Originally the O.B. Department had intended to give us actual commentaries from gliders in flight.

Tests were conducted to this end, an ultra-short wave transmitter being installed in a two-seater glider, but when the commentator left Mother Earth the ground receiving squad found it quite impossible to keep him in tune . . . for an unexpected reason.

It was discovered that the wavelength of the transmitter changed every few moments. The transmitter itself was known to be stable, so a variable factor had to be sought for. It turned out to be the aileron wires of the glider. Apparently with each change of wing position the wires altered the aerial capacity.

Sophisticated

THOSE late-night monthly revues of last winter, aimed at the sophisticated 10 o'clock audience, were a tremendous success, thanks largely to the irrepressible Nelson Keys, who was the presiding artist on each occasion.

It is understood that another similar series will be begun shortly, probably in December.

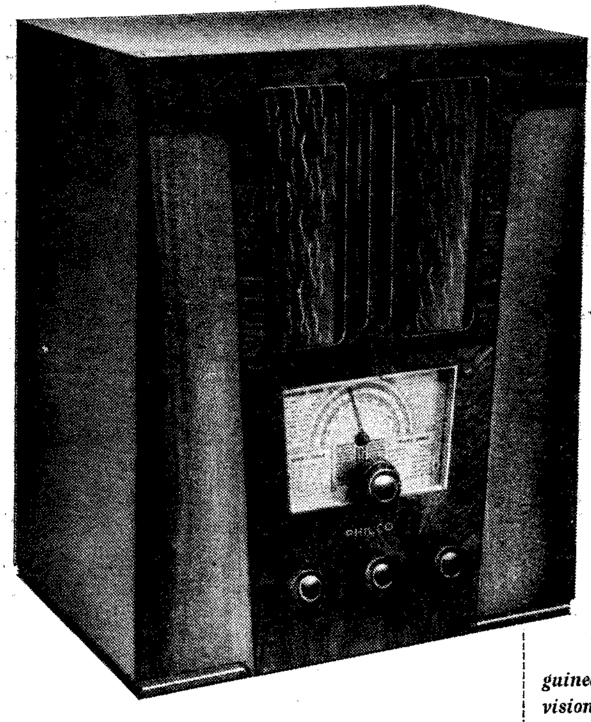
New Broadcast Serial

BROADCAST serials have not hitherto met with a great deal of success, largely because listeners, however spellbound they may be at the thrilling conclusion of an instalment, usually forget to tune in at the appointed time a week later. Nothing daunted, the B.B.C. will make another attempt at a serial next week.

The first instalment of "The Strange Adventures of Mr. Penney," by Maurice Moeseiwitsch, will be broadcast on the Nationals on Saturday, November 21st, the first episode being "Mr. Penney on Government Service." If advance information is to be believed, Mr. Penney's personality is such as to ensure that nobody forgets to tune him in every Saturday.

Laughs from America

THE cream of American humour will be poured into the Regional programme on November 21st in a feature entitled "Laugh That Off."



Philco MODEL 471

A MODERATELY PRICED ALL-WAVE SUPERHET WITH A LIVELY PERFORMANCE

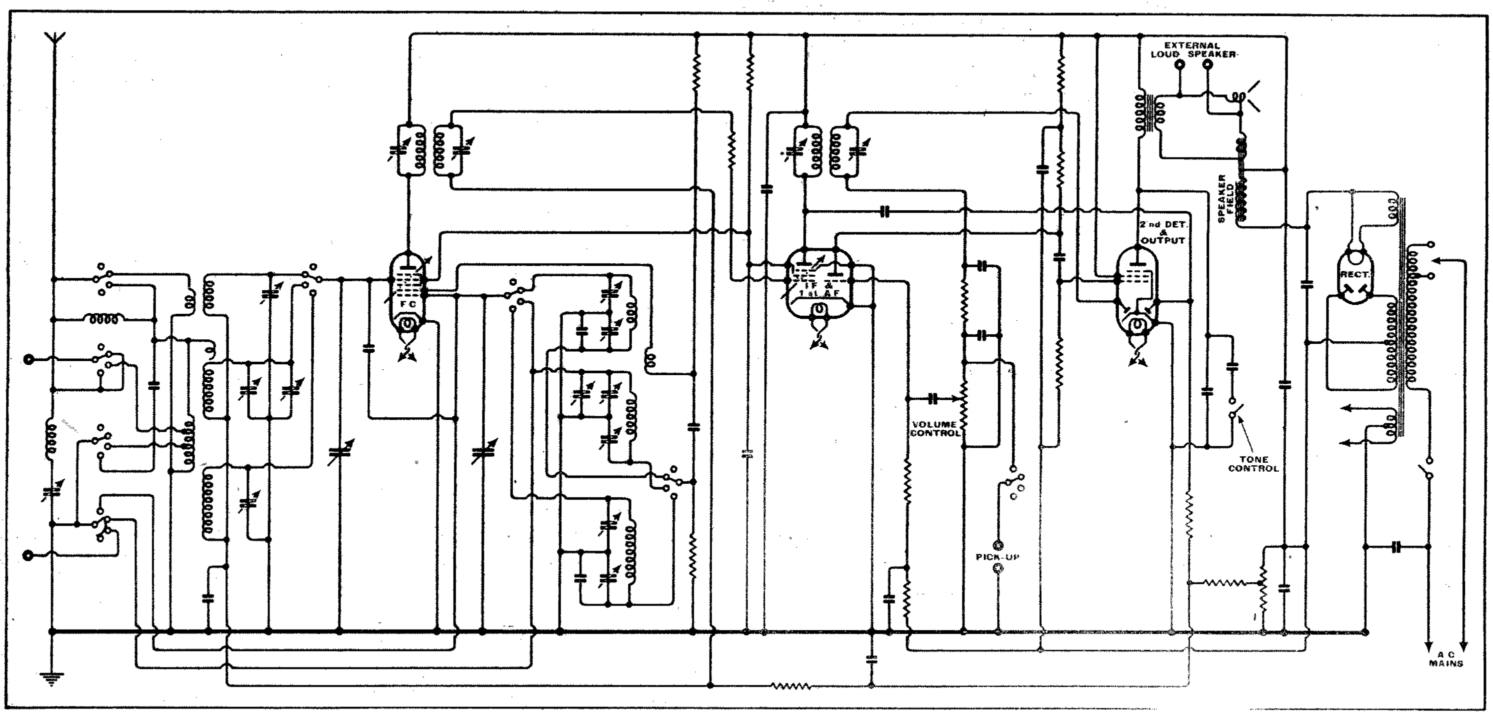
FEATURES.—***Type.***—*Table model superheterodyne for AC mains.* ***Wave-ranges.***—*(1) 18-5.75 Mc/s (16.6-52 metres). (2) 1510-530 kc/s (198-566 metres). (3) 320-150 kc/s (937.5-2,000 metres).* ***Circuit.***—*Heptode frequency-changer—triode-pentode IF and first AF amplifier — double-diode pentode second detector and output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Waverange. (4) Tone.* ***Price.***—*10 guineas.* ***Makers.***—*Philco Radio and Television Corporation of Great Britain Ltd., Perivale, Greenford, Middlesex.*

THE experience of the Philco organisation in the production of all-wave receivers is a long one, and their more ambitious sets already hold an established position in the industry. The recent extension of interest in short-wave reception, however, has called for a receiver at a more moderate price, and the Model 471 is the result. While perhaps lacking in some degree the refinement of performance of the more expensive models, there is yet little doubt that the makers have succeeded in retaining the vitality of performance which is characteristic of Philco sets. Also, there is nothing cheap in the appearance of the cabinet work, which is both well proportioned and highly finished.

In any receiver the tuning dial is usually one of the first features to come up for appraisal, as its good or bad points will be constantly before the user throughout the life of the set. In the Model 471 an open semi-circular scale has been adopted, and a great improvement has been effected in the design of the pointer by providing a narrow slit through which the scale is read. The difficulty with solid pointers is that their thickness leaves an element of doubt as to which side of the bar gives the correct indication, or, alternatively, if of the true knife-edge variety they may be liable to damage in transit. The Philco type of pointer offers a very neat solution, as it is both accurate and rigid.

To British listeners, who are accustomed to think in terms of wavelength, it will come as something of a shock to find that all three tuning scales are calibrated either in kilocycles or megacycles, but the initial period of training during which the listener is becoming accustomed to think in terms of frequency will be made easier by the fact that the more important stations are listed at the sides of the dial with their appropriate frequencies. It is interesting to note in the case of the short-wave stations the exact settings of individual transmissions are indicated instead of the usual practice of marking the broadcast bands on the dial itself.

The set was first of all put through its paces on the short-wave range, and no difficulty was experienced in tuning in Bound Brook, W3XAL, on 17.78 Mc/s, and Schenectady, W2XAD, on 15.33 Mc/s. The demands made on account of fading by these two stations were easily met by the AVC system, and both programmes were listened to for periods of about an hour without a single interruption. In the absence of an RF amplifier and its additional tuned circuit it is only to be expected that double tuning points will be found on the short-wave range. These are sufficiently wide apart, however, to



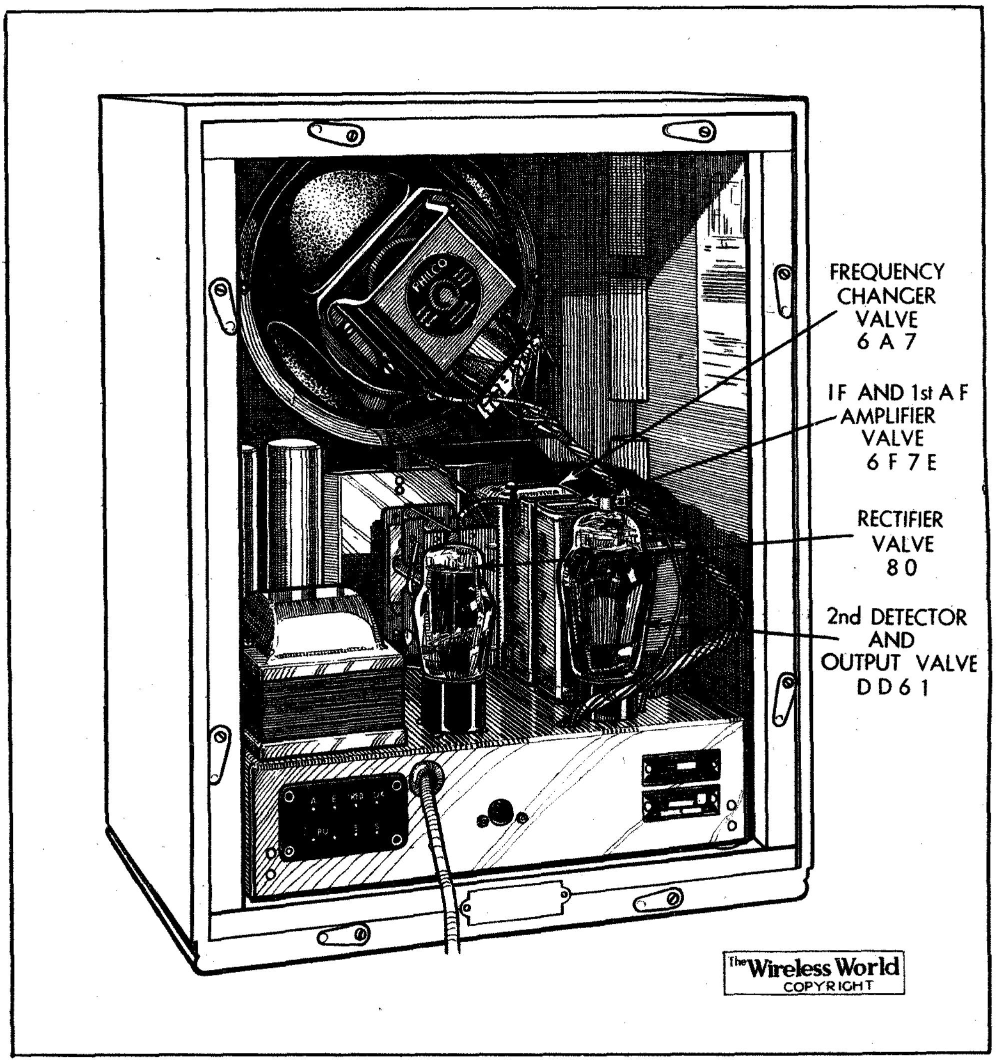
The circuit is notable for the use of a triode-pentode valve combining the functions of IF amplification and first-stage AF amplification between the diode rectifier and the pentode amplifier in the output stage.

Philco Model 471—
avoid confusion as to the identity of any given station. Actually the two tuning points are separated by something less than a megacycle, indicating that the intermediate frequency is of the order of the conventional 465 kc/s. Furthermore, the strength of the signal at the second tuning point is reduced by more than a half, so that no confusion should arise as to which is the correct setting.

The background noise between stations on short waves is remarkably low, and might at first give the impression of low sensitivity. This impression will be effectively dispelled after the first two or three stations have been received. Another good point is the manner in which the sensitivity is maintained at the high-frequency end of the scale; and this applies with equal force to the performance on the medium-wave range, where after dark the scale will be found to be full of stations of good programme value. A fair number of self-generated whistles were distributed throughout this range, but only one at about 830 kc/s gave rise to serious concern when using the set in Central London. Here the interference from the Brookmans Park transmitters extended over two channels on either side of their normal settings. On the long waveband there was comfortable separation between Droitwich and Radio-Paris, but not quite enough room between these stations for satisfactory reception of the Deutschlandsender.

We were very favourably impressed by the quality of reproduction, which had neither of the usual faults of hardness in the upper middle register or a falsely resonant bass. Nevertheless, there was quite as much low-frequency response as one has a right to expect from the baffle area available in a table model cabinet. Perhaps the greatest surprise was to find such a high degree of clarity in the reproduction of pianoforte tone and the excellent segregation of instruments in concerted music.

The two-position tone control gives a rather fierce suppression of the upper half of the audio-frequency scale, and throughout the course of the tests we experienced not the slightest inclination to make use of the deep-toned position. Neither was there any feeling that a continuously variable tone control was necessary, as the balance of tone in the normal position of the switch seemed exactly right, even for reception on the short-wave range, where in most cases the reduction of high-note response is the usual expedient for reducing background noise.



The chassis is of simple and robust construction and the specification includes an 8-inch moving-coil loud speaker.

Such novelties as are to be found in the circuit diagram are related to the arrangement of the stages of amplification rather than to the associated coupling circuits. The first valve is a heptode frequency-changer operating in a balanced circuit to ensure stable operation on the short-wave range. The employment of a triode-pentode valve in the IF stage is unusual. The pentode section takes care of the IF amplification, and the triode functions as a first AF amplifier between the signal diode rectifier and the output stage. The latter is a pentode incorporated in the same envelope as the diodes. The AVC rectifier, incidentally, is quite separate from the second detector circuit.

The set is designed for AC mains voltages between 200 and 260, and the set as despatched from the works is adjusted for supplies between 230 and 260 volts. To alter the primary tapping for mains voltages between 200 and 230 volts, the chassis must be removed from the cabinet. The connections of all auxiliary components are made to sockets assembled on a single panel at the back of the chassis. In addition to the usual aerial and earth terminals there are sockets for the attachment of the Philco All-wave Noise Reducing Aerial, a 2-3-ohm extension loud speaker, and a gramophone pick-up.

To summarise, the sensitivity and range of the Philco Model 471 are more than sufficient to give the beginner an insight into the possibilities of long-distance short-wave broadcasting, and the quality of reproduction would do credit to a receiver of considerably higher price.

The Radio Industry

DEMONSTRATIONS of television reception at the G.E.C. offices in Kingsway, London, W.C.2, are given daily at 3 and 9 p.m. until further notice. So great has been the attendance that extra space has been needed.

The fourth annual dinner of the British Radio Cabinet Manufacturers' Association will be held on Monday, November 16th, at the Piccadilly Hotel at 7.15 p.m. Tickets can be obtained from Mr. E. J. Ellis, First Avenue House, High Holborn, London, W.C.1.

It should be made clear that "Sunray" (and not "Sunbeam") is the trade name of the receivers made by Sunbeam Wireless Service, which were referred to in our recently published classified list of all-wave sets.

Cosmocord, Ltd., Enfield, Middlesex, have just issued a new catalogue of playing desks and pick-ups; with each copy a useful stroboscopic speed tester is given free.

H.M.V. announces two price increases: Model 488 five-band radio-gramophone, from 28 to 29½ guineas, and Model 485A five-band "autoradiogram," from 36 to 38 guineas. At the same time, two new H.M.V. models, both costing 25 guineas, are announced; these are three-band radio-gramophones, Models 492 and 487, for AC and AC/DC supplies.

The Electradix Sale Catalogue contains details of much useful equipment, including ex-Government apparatus of special interest to amateur transmitters. There is also a new microphone list giving details of many different types.

Current Topics

EVENTS OF THE WEEK IN BRIEF REVIEW

Norwegian Listeners Aggrieved

IT is not only listeners in this country who are troubled by the sponsored programmes emanating from certain Continental stations, as complaints have been made to the U.I.R. by the Norwegian P.O. that it is impossible to listen to Stavanger at certain hours owing to Radio Normandie intruding upon the same wavelength. In the meantime it has been decided temporarily to change the wavelength of Stavanger to 352 metres.

Football and Broadcasting

THE football interests in France appear to be as hostile to broadcasting as they are elsewhere. Recently the Lille station made an effort to broadcast a very important match, but the necessary permission was withheld by the French Northern Football Association. The reason for these refusals is, of course, that the size of the "gate" is said to be seriously affected when people have the opportunity of listening to a running commentary in their own homes.

I.E.E. to Discuss Wireless Amateurs

A MEETING of the Wireless Section of the I.E.E. will be held at 6 p.m. on November 18th when Dr. E. Mallett, the chairman of the section, will give the inaugural address. On November 25th at 6.30 p.m. there will be a discussion on "The Scope of the Amateur in the Development of Radio Engineering."

Three Million French Listeners

ON October 1st the number of French listeners was 3,031,526. France is now third among European countries in the matter of listeners, the first two being Great Britain and Germany. Sweden, which follows France, has rather fewer than one million listeners.

PA Institute

THE newly formed Institute of Public Address Engineers has now been duly registered. The Institute, under the chairmanship of Mr. D. B. H. Robinson, aims at placing the PA industry on a firm basis and encouraging technical developments. The secretary is Mr. L. B. Candfield, 266, Kingston Road, Teddington, Middx.

Sponsored Programmes

NO fewer than 73 of America's leading national advertisers employed radio as a medium in 1935, and of the 27 abstainers nine were firms connected with the liquor trade, the advertisements of which are not accepted by the broadcasting stations. The revenue derived by broadcasting from these 73 advertising firms during 1935 was approximately 7½ million sterling.

Wireless Exhibition Attendances

IT is interesting to compare the attendance figures for the various Continental exhibitions with the 202,517 of Olympia. At the Paris Salon there were 230,000 visitors, but this figure was surpassed at the Italian show, where 270,000 people passed the turnstiles. Berlin was better, with 317,000 visitors, while Warsaw has easily beaten them all with over 400,000. The exact figure has yet to be published by the Polish authorities. These figures are not, of course, strictly comparable owing to the fact that the various shows were not all open for the same length of time.

An Engineering Appointment

MR. W. J. BROWN, B.Sc., A.M.I.E.E., has taken up an appointment as Director of Engineering to the Philco Company. Mr. Brown, who took a 1st Class Honours degree at Manchester University, has had a long association with broadcasting; after spending a short time at the N.P.L. he joined Metropolitan Vickers and assumed technical control of the old 2ZY station. He was subsequently placed in charge of the Company's research station, being responsible for the first rebroadcasting of KDKA, at the time working on 100 metres. Later, Mr. Brown joined The Gramophone Company, of which he became Chief Designs Engineer. His paper on the High Fidelity Radio Gramophone, read before the I.E.E. last year, attracted much attention, and gained the award of a special premium. He was recently invited to join the Wireless Section Committee of the Institution.

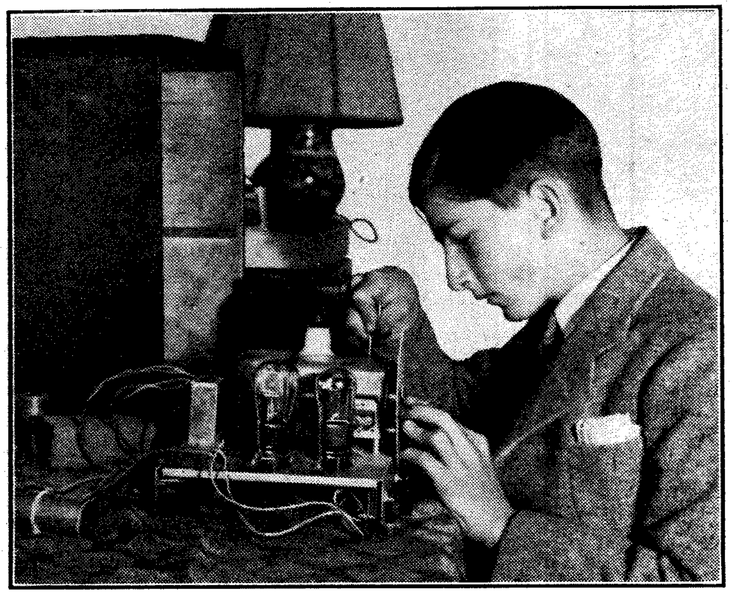
Factory Wireless Club

MANY firms of wireless set makers endeavour to encourage their employees to take an interest in the subject outside normal working hours by encouraging the formation of wireless societies in their works. The latest firm to do this is Murphy Radio. At the inaugural meeting Mr. L. A. Moxon, G6XN, dealt with the question of amateur transmission.

Danish Short-wave News

APPARENTLY this is not the only country which is troubled by wireless pirates, but whereas over here they are mostly listeners, in Denmark they take the form of transmitters. This form of piracy became such a menace about a year ago that the Danish Union of Amateur Transmitters, finding that the offenders were getting the transmitting fraternity a bad name among broadcast listeners, determined to supplement the Danish P.M.G.'s detective work by a little direct action of their own. As a result thirty-one pirates were detected, in addition to the eleven found by the P.M.G.'s department. Of this number seventeen decided to take out licences and become law-abiding transmitters.

The amateur transmitting movement is going steadily ahead in Denmark, there now being 440 members of the transmitting union compared with 298 a year ago.



A ROYAL CONSTRUCTOR. Thirteen-year-old King Peter II of Yugoslavia is an ardent believer in home construction, and is seen here building a two-valve mains set.

Diaries for 1937

MOST readers are familiar with *The Wireless World* Diary, the 1937 edition of which is now available. Similar in appearance and general make-up, diaries are now available for readers of *The Autocar*, *The Motor Cycle* and *The Amateur Photographer*. Any of these can be obtained at a cost of 1s. 6d. through any bookseller, or direct from the publishers, Messrs. Iliffe & Sons Ltd., Dorset House, Stamford Street, S.E.1, at a cost of 1s. 7d. post free.

Next Week's Issue

The appearance of the VALVE DATA NUMBER of *The Wireless World* is now looked forward to as an important annual event. A specially prepared

VALVE DATA SUPPLEMENT

will be included in this enlarged number, in which will be given a full list of over 850 valves now on the market, including American types, with tabulated details of their properties. Special articles on new valve developments will also be a feature of the number.

Early PA

SOUND AMPLIFICATION IN THE ANCIENT WORLD

By C. ERIC DUST

A WRITER on the subject of the Berlin Olympic Games recently made a comparison between the modern contests, of which the results are given to spectators through loud speakers, and the ancient Olympiads, held long before the days of "Public Address."

But is PA really such a new thing? Convincing evidence of the early use of apparatus to amplify the human voice is plentiful in all parts of the world.

The use by the Greeks of amphorae to amplify the voices of actors in stage plays is interesting, as it shows that they possessed a not inconsiderable knowledge of acoustics. A number of jars were placed at various positions round the stage and were partly filled with liquid until they were "tuned" to the voice frequency desired. The voice was amplified by the sympathetic response of the jars.

It is probable that some similar method was used at Delphi and other homes of the oracles. Do we not read of "The Sybil at Cumæ hanging in a jar?" In these cases the amphorae were probably used to add an "unearthly" atmosphere to the pronouncements of the seers as well as to amplify their words. Greek history records that on many occasions the oracles addressed large audiences.

It has been suggested that the ancient Egyptians understood how to construct their temples and theatres so that the voice was actually amplified and not absorbed, as is so often the case in modern buildings.

Perhaps the Egyptians learnt this art from the natural "whispering galleries" which are to be found in many parts of the world. Incidentally, these galleries must often have been used by sentinels to warn their people of the approach of enemies, and one can readily imagine the ordered alarm of some hill village occasioned by the hollow roar of warning—the amplified voice of the lonely outpost perhaps two or three miles away.

Anterior to the Greek and Egyptian PA was the use of the drum; whilst this does not amplify the voice it is undoubtedly a method of public address and a very effective one at that.

The cunningly devised tree-trunk body of the African drum "addresses" vast numbers of people at a much greater distance than would be possible with our up-to-date equipment. He who has heard the "lokali" can never forget its mysterious throb and all who know Africa will testify to its efficiency; detailed information is sent and understood, but only by the natives; never the white man.

The moose call of the North American Indian is possibly the ancestor of the modern megaphone. In this case the human voice is used, the hunter imitating the cry of the moose, which is amplified and made directional by the horn. The quality of reproduction is presumably good, as it is said that any moose within hearing will answer the call.

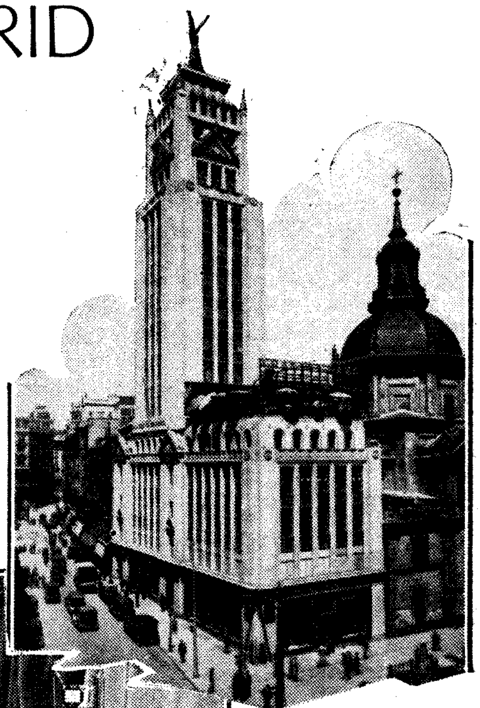
These instances will be sufficient to prove that amplifying equipment is not new by some thousands of years. It only remains for some intrepid explorer to find the fossilised remains of a prehistoric thermionic valve in the Gobi Desert to prove that we have actually made little advance since the Stone Age. As, however, this discovery has yet to be made, we can still pride ourselves on being such clever fellows as to have devised our modern sound-amplifying equipment.

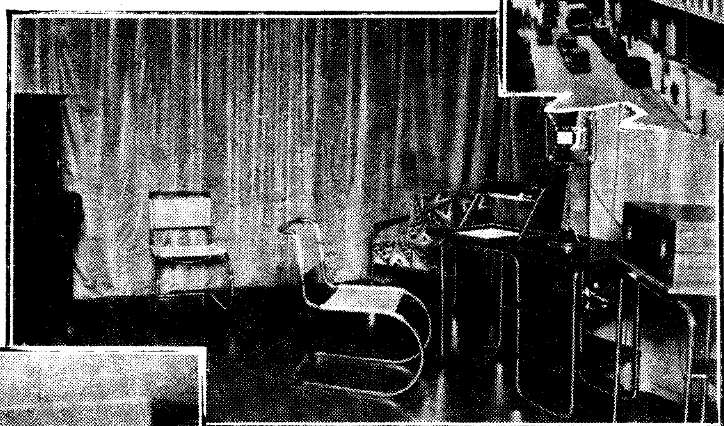
E.A.Q. MADRID

The Voice of Spain Calling

THROUGH all the tragic happenings in Spain during the last few months this call has been heard regularly up to the time of writing just before the threatened capture of the Spanish capital.

E.A.Q., with its studios in Madrid and its transmitting aerial at Aranjuez, 35 miles south-east, is a 80-kW transmitter working on 30.4 metres. Its power and excellent modulation, together with the fact that it caters for both English- and Spanish-speaking listeners in Europe and North and South America, made it familiar all over the world. Each night from 10.15 p.m. to 2.30 a.m. Greenwich Mean Time it transmitted a programme of music and lectures, with an additional programme, intended for English-speaking listeners, from 5 till 7 p.m. on Saturdays.





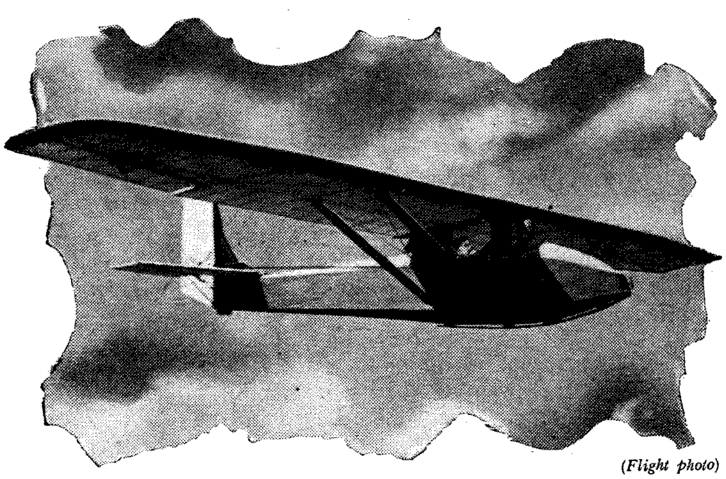
EAQ headquarters in Madrid and two interior views, one of the talks studio and the other the British-built Marconi transmitting equipment at Aranjuez.

In the spring of each year for the last few years a special programme arranged by the London Chapter of the International Short Wave Club, and broadcast from E.A.Q., has brought hundreds of appreciative letters from all parts of the world.

It is natural, therefore, that during the present upheavals in Spain, short-wave listeners have lent a sympathetic ear to this station, which has maintained its programmes under the most trying conditions. For the most part the station has functioned normally, but on those occasions when an aerial bombardment has been threatened or had actually taken place a hurried removal had to be undertaken to an improvised studio underground which has been reasonably secure from the effect of bombing by the insurgent forces.

Listeners' Guid

Outstanding Broadcasts at Home and Abroad



(Flight photo)

DIFFICULTIES WITH THE AERIAL prevented a first-hand description by a novice from a two-seater glider of this type being given in the broadcast on Saturday. The reasons for this are given in Broadcast Brevities.

OPERA lovers are unusually well provided for in the home programmes this week, which include relays from Turin and Sadler's Wells.

Studio opera is a rare happening in British broadcasting at the present time and will remain so until after Stanford Robinson's return next year from his Continental opera tour. On Tuesday, however, a relay from Turin will give listeners the opportunity of hearing studio opera as produced in Italy, where it has been developed to a very high degree. The first act of Massenet's "Manon," with the E.I.A.R. Orchestra and Chorus, will be relayed at 7.45 (Reg.). Magda Olivero plays the part of Manon and Emilio Chirardini that of Lescaut.

From Sadler's Wells on Wednesday at 8 (Reg.) comes Act I of Puccini's "Madame Butterfly," with the name part taken by Joan Cross and Tudor Davies in the rôle of Lieutenant Pinkerton.

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THE ALHAMBRA

ON November 1st this famous playhouse in Leicester Square passed into the hands of the housebreakers to clear the way for a super-cinema. The Alhambra holds many memories for Londoners and visitors alike, and some of them will be recalled in a programme devised by John Watt and Robert Gilliam, which they are to produce Regionally on Monday at 6.30.

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GLIDING

THE Director of Outside Broadcasts, Mr. S. J. Lotbinière, was so thrilled with the sensation of his first flight in a glider that he has arranged a glider broadcast from Dunstable Downs on Saturday at 3, in the National programme.

Three or four mobile transmitters will be at vantage points on the Downs and T. Woodrooffe and S. J. Lotbinière with two experts of the London Gliding Club will give commentaries on various flights. These will include a novice's ground-hopping flight in which the glider is towed by hand or by car, then a more advanced flier will go up on what is known as a second stage flight, and finally an expert will give a demonstration of how gliding—and, with the right wind—soaring should be done. The commentaries will be picked up by the O.B. van and relayed to London by land line.

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CONTRASTS

THERE exist many contrasts in village life, and some of them will be brought out in the programme, "Manor to Mine," to be produced by Robin Whitworth on Monday at 9.35 (Nat.). Three Nottinghamshire villages will be contrasted. First mediæval Laxton, where the open-field system of agriculture still survives; then Caunton, Victorian and dreading urban encroachment; and, finally, Ollerton, where industrialisation is definite and many farm workers have become miners.

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IN PARIS

THE story by Mrs. Belloc Lowndes, "The End of Her Honeymoon," which many listeners will have read, has been turned into a radio play which Lance Sieveking will produce for National listeners on Tuesday at 9.40. For the sake of those who have not read the book, I should, perhaps, say that the story deals with a young bride who goes to Paris with her husband for their honeymoon during the Exhibition of 1900. The hotel at which they stay is so crowded that they have to sleep in separate rooms; at breakfast her husband is missing; everybody denies having seen him, and the hotel staff even go to the extreme of telling her she arrived alone. For all her searching she never sees her husband again. The mystery is ultimately cleared up two years later. This uncanny story should make good listening, but be prepared for hair-raising developments.

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THE BOXER RISING

IN this week's episode in the "I Was There" series on Sunday at 6.30 (Reg.), J. Murphy will tell listeners of the happenings at the Legations in Peking during the terrible siege in 1900 on the occasion of the Boxer Rising. Mr. Murphy was senior N.C.O. of the Royal Marine Guard at the British Legation, which was besieged from June 14th to August 14th.

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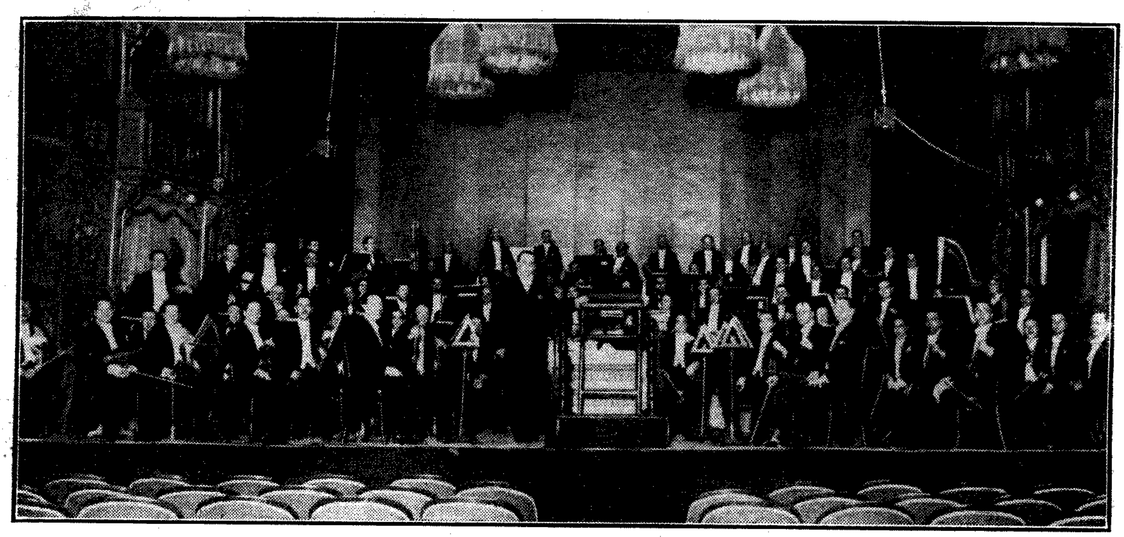
W. S. GILBERT

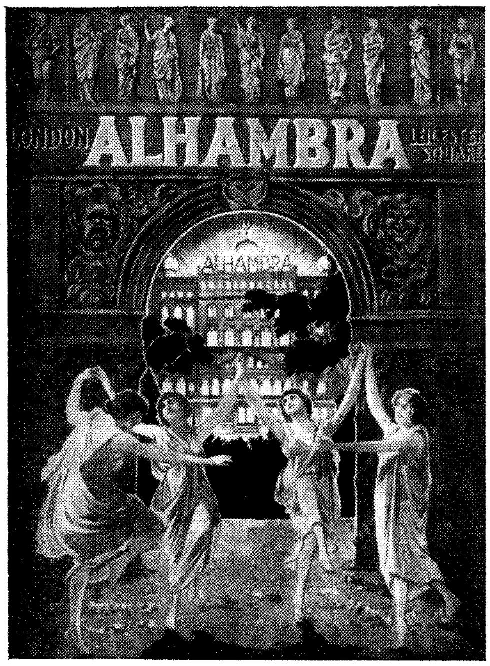
A TWENTY-MINUTE programme commemorating W. S. Gilbert, who was born in 1836 and died in 1911, will be given by J. Francis Toye on Wednesday at 7.55 (Nat.). This barrister, poet and playwright will be best remembered for his work as librettist of the famous Gilbert and Sullivan light operas.

Details of the week's Television programmes will be found on p. 507.



E.I.A.R. ORCHESTRA in the large concert hall studio of Turin. This orchestra will be heard in the Regional relay of "Manon" from Turin on Tuesday.

e for the Week



BACCHANTE BALLADS

A SELECTION of the songs written by Carl Michael Bellman, the great Swedish composer of ballads, whose music is so well known all over the world, will be given in a special programme from Kalundborg on Sunday at 8.25. The soloist will be Alf Gildsig, the foremost interpreter of Bellman's songs in Denmark.

OPERA AND OPERETTA FROM ABROAD

THE Prague broadcast of Mozart's "Magic Flute" from the German Theatre is the one opera event of Friday, and will be heard at 6.30. This opera was the last great effort of the master, who died two months after its production.

From the Royal Flemish Opera House will be heard Gounod's "Faust," relayed by Brussels No. II at 8 on Saturday. An abridged version of Kálmán's famous operetta, "Gräfin Maritza," adapted for Danish broadcasting, will be relayed from the Concert Hall studio at Copenhagen at 2.25 on Sunday.

WOMEN COMPOSERS

TUESDAY'S *émission fédérale,* from the French Regional stations, consists of the works of French women composers. This will be given at 8.30 by the National Orchestra, conducted by Inghelbrecht, and will include the Symphonic Poem, "L'Irlande," by Augusta Holmes, and a piece obviously inspired by the Great War, "Pour les funérailles d'un soldat," by Lily Boulanger, who died at the age of twenty-four in 1918. Also included in the programme is the Ballet, "Le marchand d'oiseaux," by Germain Taillefère.

PATRONS OF THE ALHAMBRA will remember this design which was used on the variety programmes of that famous old playhouse for many years. Reminiscences will be broadcast in a special programme on Monday.

LATVIAN

ON Wednesday Radio-Paris celebrates the Latvian National Festival with a special concert at 8. The Latvian Minister in Paris will give an address at the beginning of this concert, which will be composed entirely of Latvian music.

MUSICAL PLAYS

TWICE this week from Frankfurt will be heard musical radio plays written around well-known classical works. The first is to be given on Sunday at 7, when a story will be woven around Johann Strauss' famous waltz, "Stories of the Vienna Woods." The second, "Music in Candlelight," is written around Beethoven's Spring Sonata.

HIGHLIGHTS OF THE WEEK

FRIDAY, NOVEMBER 13th.

Nat., 7.40, Trailer of "L'Aiglon." 8, "Money for Jam"—musical drama by Max Kester. 9.45, Act II of "Don Giovanni."

Reg., 6, B.B.C. Theatre Orchestra, and Ina Souez. 7.30, Van Phillips and his Two Orchestras. 9.20 9.20, B.B.C. Military Band.

Abroad.

Deutschlandsender, 7, London Philharmonic Orchestra, conducted by Sir T. Beecham from the Philharmonie, Berlin.

SATURDAY, NOVEMBER 14th.

Nat., 3, Gliding. 6.45, B.B.C. Orchestra (C). 7.30, "In Town To-night." 9.20, Music Hall.

Reg., 4.15 "Money for Jam," 6, Reginald King and his Orchestra. 8, Recording by the Boston Orchestra of "Rhapsody in Blue." 9, The Haigh Marshall String Quartet.

Abroad.

Brussels II, 8, "Faust," from the Royal Flemish Opera, Antwerp.

SUNDAY, NOVEMBER 15th.

Nat., 5.35, "L'Aiglon." 7.5 Recital: Bratza (violin) and John Wills (piano). 9.45, The Grand Hotel, Eastbourne, Orchestra.

Reg., 5.30, Johann Strauss Potpourri—Theatre Orchestra. 6.50, Commodore Grand Orchestra. 9.5, Studio Orchestral Concert.

Abroad.

Konigsberg, 7.10, "Thousand and One Nights": Operetta (Johann Strauss).

MONDAY, NOVEMBER 16th.

Nat., 7.20, Entertainment Parade—IV. ¶Van Phillips and his Two Orchestras. 9.35, "Manor to Mine."

Monday, November 16th (*contd.*).

Reg., 6, Students' Songs; B.B.C. Men's Chorus. 6.30, "Farewell to the Alhambra." 7.30, "L'Aiglon." 9 B.B.C. Orchestra (E) and Heddle Nash.

Abroad.

Strasbourg, 8.30, Alsatian Soirée followed by light music.

TUESDAY, NOVEMBER 17th.

Nat., 6.25, B.B.C. Empire Orchestra and John Simons (piano). 8, B.B.C. Theatre Orchestra. 9.40, "The End of Her Honeymoon."

Reg., 6, Eugene Pini and his Tango Orchestra. 7.45, "Manon." Act I (from Turin). ¶B.B.C. Dance Orchestra.

Abroad.

Paris PTT, 8.30, Concert of Music of Women Composers.

WEDNESDAY NOVEMBER 18th

Nat., 7.15, Fred Hartley and his Novelty Quintet. 8.15 and 9.25, Symphony Concert from the Queen's Hall.

Reg., 7.30, "The World Goes By." ¶The Rocky Mountaineers. 9.30, Commentary on Foord-Neusel Boxing Match.

Abroad.

Leipzig, 7, Missa Solennis (Beethoven) relayed from St. Thomas's Church.

THURSDAY, NOVEMBER 19th.

Nat., 6.20, "This Way Out"—John Hilton. ¶Wireless Puppets. 9.20, Commentary on Table Tennis Match.

Reg., 6, The Black Dyke Mills Band—Original Compositions for Brass. 8, Act I of "Madame Butterfly" from Sadler's Wells.

Abroad.

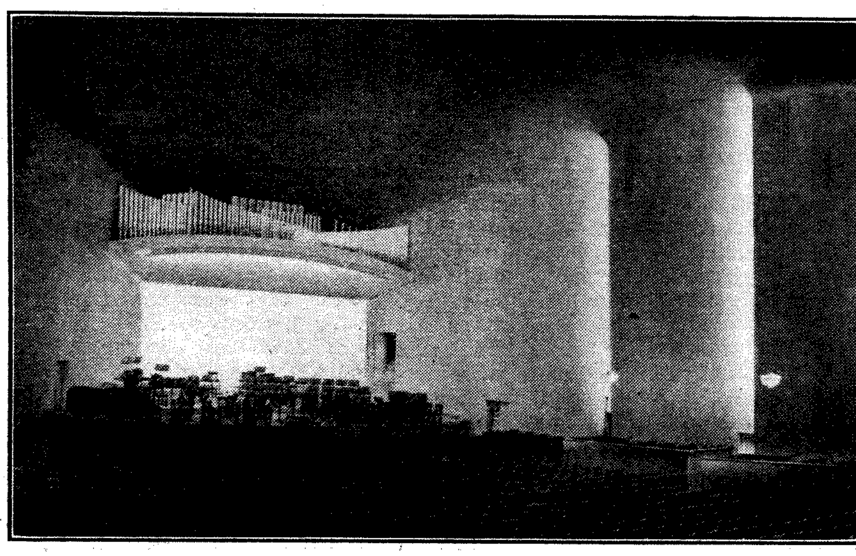
Kalundborg, 7.10, Ninth Thursday Concert from the State Broadcasting Building.

SYMPHONIES

THE second concert in a series, "Don't be Frightened by a Symphony," from Deutschlandsender at 8 on Thursday, is intended to introduce listeners to good music which they would not otherwise listen to if announced in the ordinary way.

SWEDISH SCOUTS

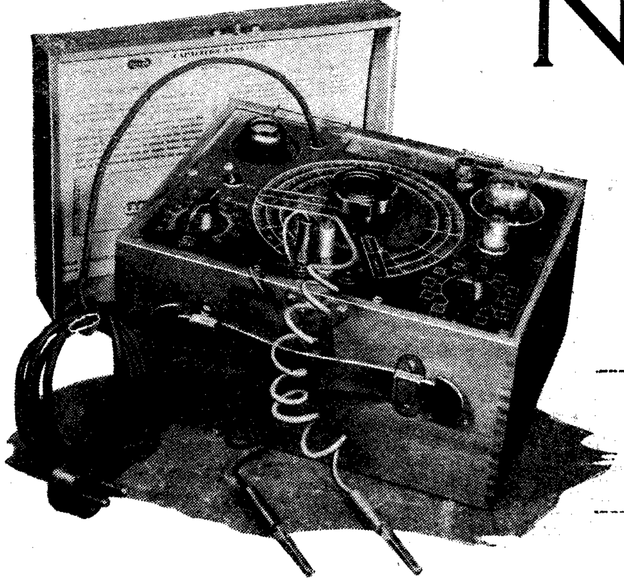
THE Silver Jubilee of the Swedish Boy Scout Movement will be celebrated by a special programme to be broadcast on Sunday at 3 by the Swedish stations. It will consist of outside broadcasts from camp fires in seven different parts of the country. THE AUDITOR.



THE CHARTERHOUSE SUITE by Vaughan Williams is to be among the items in a concert by the Göteborg Kammarorkester which Swedish stations will relay on Tuesday at 9.0 from the Konsertföreningen which was built acoustically for broadcasting and is here shown.

New Apparatus Reviewed

Recent Products of the Manufacturers



AC mains-operated capacity and resistance test set obtainable from A. H. Hunt.

HUNT'S CAPACITY ANALYZER

THIS test set has been evolved for the purpose of measuring capacity and resistance in a simple and straightforward manner and to a high order of accuracy.

It operates entirely from the AC mains and all measurements are read direct from calibrated scales. Its principle is that of a bridge and indication of balance is given by a miniature cathode-ray device of the kind now used in receivers as a tuning indicator.

Two valves are employed, one is a half-wave rectifier giving DC for operating the cathode-ray indicator, which is an American Type 6E5. Apart from measuring capacity and resistance, the test set gives an indication of a defect in any condenser. Leakage in any form is shown either by a continuous glow or by an intermittent flashing of a small neon tube. If the condenser is disconnected internally a balance cannot be obtained.

The bridge gives direct measurements of condensers of from 0.00001 mfd. to 70 mfds. in three ranges and of resistances from 50 ohms to 2 megohms. Paper, mica and electrolytic condensers can be dealt with, and in the latter case there is also provided a calibrated scale for the measurement of power factor.

Our tests show that condensers can be measured to an accuracy usually better than one per cent., comparisons being made with standard grade laboratory equipment. This degree of accuracy is more than adequate for all commercial purposes, so that the instrument should prove a valuable adjunct to the equipment of service engineers and also to that of the factory test room.

The instructional book provided is exceedingly well prepared and explains most lucidly the principle and operation of the bridge. When dealing with leakage tests it says that condensers, other than electrolytic, that cause the neon tube to flash more frequently than one per second may be regarded as unsatisfactory for most positions in a set.

Tests made to ascertain what order of leakage resistance is indicated by this periodicity of flashing show that it is of the order of 20 megohms. It can thus be seen that the sensitivity on leakage test is very high indeed, for a leakage resistance many times this amount will still cause intermittent flashing of the tube.

The instrument, which is of American origin, is obtainable from A. H. Hunt, Ltd., Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18, and the price is £9 15s.

PERTRIX BATTERIES

ABOUT six months ago a test was commenced with the view to ascertaining what effect storing an HT battery would have on its working hours. The facilities for carrying out this test were offered by Britannia Batteries, Ltd., Union Street, Redditch, Worcestershire, which firm supplied us with some samples of their Double-Power Non-Salammoniac dry batteries rated for a maximum discharge of 14 mA.

One battery was placed on discharge immediately, while two were put in store for three months and then discharged in exactly the same manner as the former. Both batteries that were stored gave sensibly the same performance.

The two discharge curves were then drawn on the same graph so that their performance could be compared at a glance.

Of the curves reproduced here the full-line one relates to the first sample, while the broken-line curve is for one of the batteries that had been kept on the shelf.

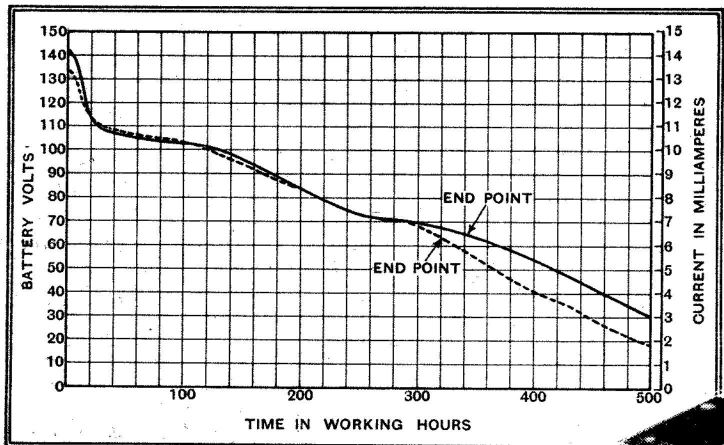
It will be seen that storing the battery has not materially affected its performance, for during the first 300 hours the two curves are almost identical, the very slight difference is no more than might be expected from two batteries taken at random and discharged at the same time.

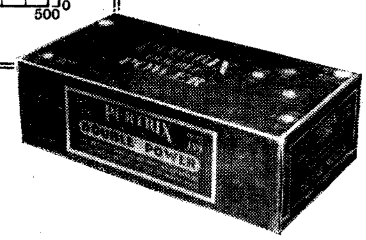
The batteries that had been stored gave only 13 hours less useful life than the other sample. In both cases the end-point was fixed when the voltage had fallen to 0.75 volt per cell.

These batteries each had 91 cells, but only 85 were used for the discharge test as the remainder were marked for grid-bias supply. With 85 cells the normal voltage is 127½, though actually it was about 140 at the beginning of the test.

The total watt-hour capacity calculated up to the arbitrary end-point is 193 for the first sample and 180 for the second model, which gives 2.3 watt hours and 2.12 watt hours per cell respectively.

It should be gratifying to users of dry batteries thus to know that, in this particular case, there was no appreciable deterioration in the life of the battery by storing it for some months.





Discharge curves of two Pertrix double-power batteries. The broken-line curve relates to a battery discharged after three months in store, the other to a battery discharged immediately after reception. (Inset) The Non-Salammoniac double-power battery of the type used for our tests.

These batteries are given the catalogue number 158 and cost 13s. 9d. each. The double-power, in a maroon and gold carton, is rated for 12 to 14 mA discharge at maximum, and is available in a wide range of models.

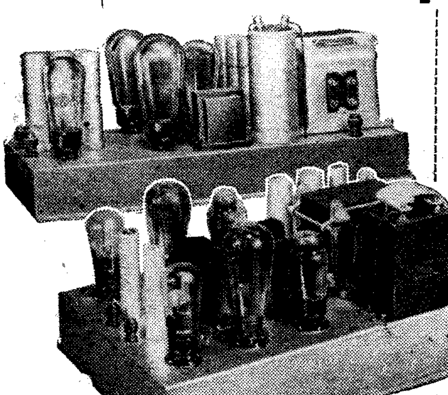
Quality Amplifiers

DEMONSTRATION AT CLACTON-ON-SEA

AT The Grove, Clacton-on-Sea, Mr. H. T. Greenfield, in conjunction with Mr. F. L. Baynton, is undertaking to exhibit and demonstrate Quality Amplifiers of their construction to *The Wireless World* designs. These demonstrations are continuing at this address for the next few weeks.

Resistance-Coupled Amplifiers

Part III.—Calculating the Performance



IN previous articles in this series the fundamentals upon which the operation of resistance-coupled amplifiers depend have been discussed. In this article it is shown how the performance may be calculated, and also how the required values of components may be determined.

ALTHOUGH it is quite possible to determine the performance of an amplifier by a mathematical extension of the theory of operation already given, it is not usually convenient to do so, for the direct derivation of the circuit equations is rather cumbersome. It is much easier to consider a steady sine wave of alternating voltage applied to the grid of a valve and to work out the problem by considering the various resistances and reactances. In the steady state, that is, for a continuously applied voltage, the answer is the same. A difference appears only when considering transients, but for the moment we can ignore this.

Let us take the simplest practical case of a resistance-coupled stage having the circuit of Fig. 7 (*a*) in which the valve V1 is coupled to the valve V2 by means of the coupling resistance R1, the coupling condenser C2 and the grid leak R2. It is required to find the ratio of the voltage e2 applied to V2 and e1 applied to V1; this ratio e2/e1 = A, the amplification of the stage. It will be noted that two condensers are shown dotted in Fig. 7 (*a*); the first c′ represents the anode-cathode capacity of V1 plus stray wiring capacities on the left-hand side of C2, while the second c″ represents the *effective* grid-cathode capacity of V2 plus stray capacities on the right-hand side of C2. Note that c″ is the effective grid-cathode capacity; it is equal to the static grid-cathode inter-electrode capacity of V2 plus an imaginary capacity which partly represents the effect of feed-back through the grid-anode capacity of V2. This imaginary capacity may be much larger than the static capacity and it is often very important. The effects of feed-back are completely represented by the addition of an imaginary resistance in parallel with R2, but in most cases it is so high in value that it can be ignored. When it is not, R2 must be taken as meaning the actual resistance R2 in parallel with the input resistance of the valve.

Because the shunt capacities c′ and c″ only have an appreciable effect at high frequencies, and C2 is negligible at all but low frequencies, it is possible to redraw the circuit as in Fig. 7 (*b*) with negligible error. Here C1 = c′ + c″, that is, the total capacity in shunt with the coupling. The equivalent circuit for alternating currents only is shown in Fig. 8, in which the valve V1 appears as a generator $\mu e1$ in series with its internal resistance Ra, and the batteries disappear.

With such a simple circuit the equation expressing the performance is equally simple, but as C1 has an appreciable effect only at high audible frequencies and is negligible at both medium and low frequencies, and C2 is effective only at low frequencies and can be ignored at medium and high, it is possible to employ three different very simple equations for expressing the performance at the different parts of the range of frequencies.

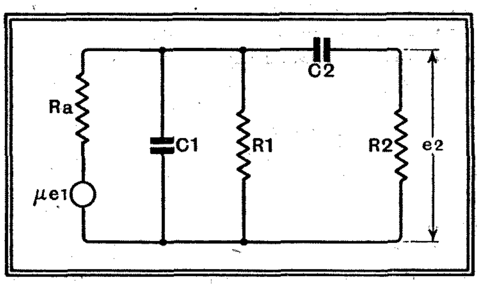


Fig. 8.—The equivalent circuit of that of Fig. 7 is shown here. The valve is represented by the resistance Ra and the generator μe1.

At medium frequencies (say, 200 c/s to 2,000 c/s)

$$A = gr \quad \ldots\ldots \quad (1)$$

At high frequencies (above 2,000 c/s)

$$A = gr \times \frac{1}{\sqrt{1 + \omega^2 C_1^2 r^2}} \quad \ldots\ldots \quad (2)$$

At low frequencies (below 200 c/s)

$$A = gr \times \frac{1}{\sqrt{1 + 1/\omega^2 C_2^2 (R + R_2)^2}} \quad (3)$$

where g = mutual conductance of $V_1 = \mu/Ra$ (A/v.)

$R = Ra\ R_1/(Ra + R_1)$

$r = R\ R_2/(R + R_2)$

$\omega = 6.28 \times$ frequency (c/s)

(Capacity and resistance in farads and ohms respectively).

In the vast majority of practical cases R is very much smaller than R2 so that, with a very small error, equation (3) can be simplified to

$$A = gr \times \frac{1}{\sqrt{1 + 1/\omega^2 C_2^2 R_2^2}} \quad \ldots\ldots \quad (4)$$

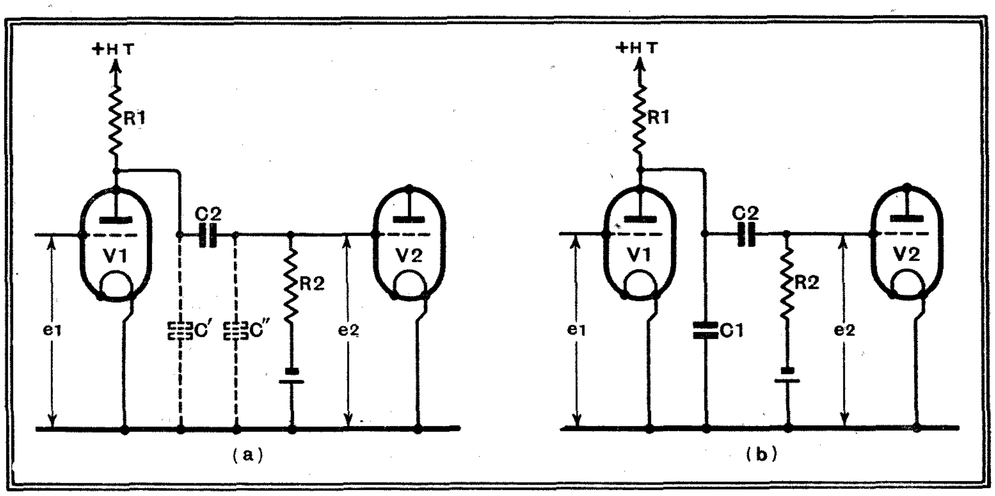


Fig. 7.—The stray capacities in an amplifier are represented in (a) by the condensers shown dotted. In practice it is possible to simplify the treatment by grouping them into the single condenser C1, as shown at (b).

Resistance-Coupled Amplifiers—

It will be seen that the gain at all frequencies is equal to gr multiplied by a factor which depends on frequency and which is equal to unity for the medium frequencies. In general, we require to know the gain as such only over this middle range, and the performance at high and low frequencies is more conveniently expressed as a relative gain, or

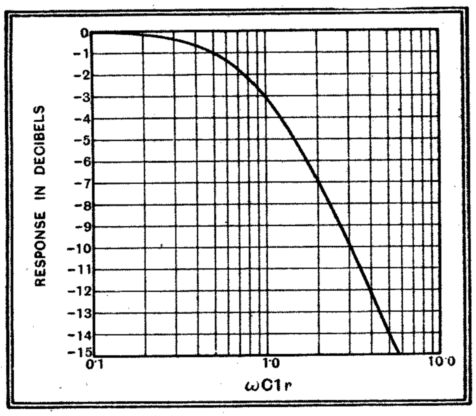


Fig. 9.—The response at high frequencies can readily be determined from this curve, as explained in the text.

better still in decibels relative to the gain at medium frequencies. This is easily done and the curve of Fig. 9 shows the falling off in the response at high frequencies for a range of values of $\omega C1r$.

This curve may be used not only to determine the actual frequency response curve of an amplifier, but to do the reverse and often more difficult calculation, to determine the value of $C1r$ which will give a certain response. Thus, suppose we say that the stage must be so good that even at 20,000 c/s the response does not fall by more than 0.2 db., Fig. 9 shows that $\omega C1r = 0.22$, so that $C1r = 0.22/6.28 \times 20{,}000 = 1.755 \times 10^{-6}$. If C1 is 200 mmfds., a by no means unlikely figure, $r = 1.755 \times 10^{-6}/2 \times 10^{-10} = 8{,}775$ ohms.

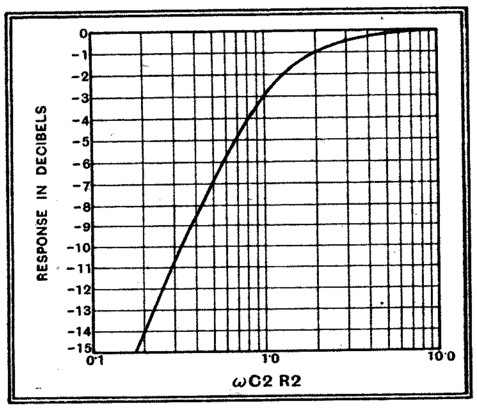


Fig. 10.—At low frequencies the response depends upon the values of R2 and C2, and may be determined from the curve.

When R2 and Ra are known, R1 can be evaluated as follows:—

$$R = \frac{rR2}{R2 - r}$$

$$R_1 = \frac{R\,Ra}{Ra - R}.$$

With $r = 8{,}775$ ohms and $R2 = 0.25$ megohm, $R = 2.5 \times 8.775 \times 10^3/2.41 = 9{,}060$ ohms and if $Ra = 10{,}000$ ohms, $R1 = 9.06 \times 10^3/0.94 \times 96{,}500$ ohms.

This result may appear surprising, for it is popularly believed that a good high-frequency response cannot be secured with a high value of coupling resistance, and 96,500 ohms is certainly a high value. Actually, it is not the value of coupling resistance which matters, but the combined value of this resistance in parallel with the valve resistance and the grid leak. The idea that high-coupling resistances were bad arose in the days when high resistance valves were employed, and it is easy to see that if the valve resistance in the above example had been 96,500 ohms, then the coupling resistance would have had to be only 10,000 ohms.

The curve may equally well be used to obtain the maximum value of C1. The most common case is in the coupling after a power grid detector when a large anode-cathode by-pass condenser, which must be included in C1 in the equations, is desirable. Suppose $Ra = 10{,}000$ ohms, $R1 = 30{,}000$ ohms, $R2 = 0.25$ megohm, and we require the same response as before, so that $C1r = 1.755 \times 10^{-6}$. We have $R = 3 \times 10{,}000/4 = 7{,}500$ ohms and $r = 2.5 \times 7{,}500/2.575 = 7{,}280$ ohms; then $C1 = 1.755 \times 10^{-6}/7.28 \times 10^3 = 2.41 \times 10^{-10}$ F = 241 mmfds. Allowing for valve and stray capacities, the by-pass condenser should be about 150-200 mmfds.

A response as good as this is rarely necessary, however, and most requirements would be satisfied by a loss of 1 db. at 10,000 c/s, for which Fig. 9 shows that $\omega C1r = 0.5$, so that $C1r = 0.5/6.28 \times 10^4 = 7.95 \times 10^{-6}$; C1 can then be as large as 1,218 mmfds. A by-pass condenser of 0.001 mfd. can be used.

A similar procedure can be used for determining the bass response, and Fig. 10 shows the attenuation for various values of $\omega C2\,R2$. This curve is used in just the same way as the other, but, of course, at low frequencies. For a drop of 0.5 db. at 20 c/s, an allowable amount, $C2R2 = 3/6.28 \times 20 = 0.002385$; if we make $R2 = 0.01$ mfd., $R2 = 0.002385/10^{-8} = 238{,}500$ ohms. Strictly, of course, it is $R + R2$ which should be this figure, but as R is of the order of 7,500 ohms in most cases it can be ignored for all but highly accurate work. Its unimportance can be seen when it is remembered that standard value grid leaks are only available in steps of 50,000 ohms. In practice, we should use 0.25 megohm for R2 in this case and obtain a slightly better response curve than we actually need.

Letters to the Editor

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

Co-axial Cables

REGARDING your leading article in the October 30th issue of *The Wireless World* concerning the use of co-axial cables and television aerials, we feel sure your readers will be interested to know that the "His Master's Voice" all-wave anti-static equipment which is now available from our dealers incorporates a co-axial transmission line. The cable is $\frac{5}{16}$in. overall diameter, is shielded, waterproofed and has extremely low loss.

This co-axial cable is also used in the transmission line for the aerial which is supplied with each "His Master's Voice" television receiver.

Owing to the fact that we are using large quantities of the cable, our all-wave anti-static aerial equipment is priced at 37s. 6d. only. Our television aerial equipment, if supplied separately, costs £4.

THE GRAMOPHONE CO., LTD.
Richard Arbib,
London, E.C.1. Advertising Manager.

Television Aerials

MAY I suggest that the inverted polar characteristics of a horizontal dipole presented to vertically polarised radiation noted by Mr. Strafford in his experiments (*The Wireless World*, October 16th, 1936), if it is assumed that no neighbouring conductor was re-radiating in such a manner as to introduce an angularly polarised component in the local field, is in fact a spurious result due to the presence of a vertical element in the receiving system, *i.e.*, the transmission line and dipole-earth capacity! In the absence of data regarding the input system it is not known what steps may have been taken to avoid mixed coupling at the receiver, but from the inversion of the polar diagram and the fact that no zero was obtained with the aerial across the wave front the symptoms would appear to be characteristic, although the latter effect is not uncommon at high field strengths under certain conditions.

In the presence of an unbalanced electrostatic component of the input coupling vertical pick-up will give rise to an EMF across the grid circuit and the system as a whole will tend to act, not as a true dipole, but as a T aerial having quarter-wave horizontals and polar characteristics rectangular to the normal distribution.

The screening of transmission lines generally presents difficulty at these wavelengths where the field strength is high, and it is not necessarily sufficient that the feeder be screened and earthed at one end—it frequently requires to be earthed at quarter-wave intervals throughout its vertical length, or to be screened by a second sheath independently earthed, such as may be provided by a flexible metallic tube. If, however, the feeder can be arranged experimentally to lie in the same plane as the dipole—*i.e.*, horizontally in the present case—the vertical element will be removed and it will probably be found that the effect will disappear.

It may be noted that no such effect (as polar inversion) was observed by Mr. Scroggie in an earlier series of experiments at these wavelengths (*The Wireless World*, August 28th, 1936) with a pure dipole arrangement, neither is it observed in vertical aerials presented to horizontally polarised waves; but it is observed as polar displacement when an unscreened or imper-

Letters to the Editor—

fectly screened transmission line introduces an element in the receiving system susceptible to angularly polarised waves and results in a form of the well-known "night effect" or "aeroplane error" vitiating the normal directivity of the system.

There is in fact no difference in the characteristic behaviour of dipole aerials in the presence of vertically and horizontally polarised radiation, and the effect noticed by Mr. Strafford, whilst not uncommon in arrangements of this kind, must, I am afraid, be regarded as fortuitous.

The "Zepp" arrangement referred to editorially in your issue of October 30th is a convenient universal device generally giving good signals, but, unfortunately, weak discrimination as regards external interference except where this is horizontally polarised. Where this is the case and in certain situations it represents an excellent arrangement, but under the more difficult electrical conditions typical of congested areas it is not generally found ideal from the standpoint of signal to noise ratio. Moreover, the concentric transmission line is more expensive than screened twin cable; but it is, of course, widely used for transmission purposes, and British-made examples of it are actually available. It is not, however, essential that co-axial cable be used—the arrangement is easily adapted to twin cable and is quite satisfactory within its limitations.

A. GORDON-FINLAY.
London, S.W.7.

Dry Battery for LT.

MR. DAVID SYMON asks if dry cells are practicable with two-volt valves? I would reply from my own experience, emphatically yes. I built the "Lightweight Portable" described in your issue of July 8th, 1931, with the circuit modified to use dry cells instead of an LT accumulator, according to the suggestions in an excellent article, under Hints and Tips, in the issue of June 24th, 1931 (to which I would refer Mr. Symon and anyone interested), and it has been in use, on and off, ever since. I incorporated a 7-ohm rheostat, acting also as a switch, in the filament circuit, and simply advance the slider until further advance does not improve reception; this point varies, of course, with the state of the LT dry battery. I have not found a voltmeter at all necessary. This set has been used by various people quite successfully, and it has given no trouble; the original Mullard valves are still in use. On occasion it has been run off a 7½d. flash-lamp battery.

So pleased was I with the performance that I built a larger, three-valve edition on my own layout: det.-2LF, the first two 0.1-amp. valves in parallel in the negative lead to a 0.2-amp. output valve in series. This set I take about with me and find very handy. It has a frame-aerial winding for long and medium bands; a throw-out aerial and earth can be attached when required (this housed in the set), and a small separate loud speaker plugged in instead of the pair of 'phones carried in the set; or a second pair of 'phones can, of course, be used. For this circuit I have found it best to use two 4½-volt dry batteries (1s. 3d. size) coupled in parallel, for LT.

I would never go back to accumulators for this class of set. R. DE S. STAWELL.
Falmouth.

Improvised AF Generator

ANYONE who has a synchronous clock can use it as a miniature audio-frequency generator by rapidly revolving the starting knob. Connected to the input of an amplifier, such a clock provides a useful testing gadget. R. ST. Q. LENG.
London, S.W.1.

N.B.C. Growing Up

Ten Years of Broadcasting

THERE are still many listeners who remember the thrill when the first American short-wave stations were received in this country. This was in those early days of American broadcasting when the first programmes of the National Broadcasting Company were broadcast *via* Schenectady, Pittsburgh and Bound Brook. These programmes originated in the small and barely furnished N.B.C. studios on the New York Broadway, where the walls were draped with paper and various odds and ends for the improvement of the acoustic conditions.

An impression of the activity that was to be found in the sound effects department of the N.B.C. ten years ago compared with its modern counterpart seen on the left.

The first N.B.C. broadcast was relayed to a chain of twenty-three stations covering a district from Boston to Kansas City. To-day, 110 stations are included in the powerful N.B.C. networks which are extended all over the U.S.A. In 1926 the total power of all N.B.C. transmitters was a little over 41 kW. In the last ten years this energy has been multiplied fifty thousand times—the power of all N.B.C. stations being over two million kilowatts! In 1926 the staff consisted of 195 persons—to-day almost two thousand persons are employed in the services of the N.B.C.

It is, of course, well known that the revenue of the N.B.C. is largely drawn from commercial enterprises, sponsoring programmes over the N.B.C. transmitters. The cost for one transmission over a coast-to-coast network is $15,000, and this does not include payment to the artistes taking part in these programmes. The artistes employed in the N.B.C. programmes number more than half a million, there being approximately 40,000 programmes a year broadcast during 14,000 hours.

The activities of the N.B.C. cover not only the U.S.A. but all the other continents. Europe is particularly popular for transmissions for American listeners. Two representatives—one in London for Great Britain and France and the other in Basle for the rest of Europe—arrange special programmes to be broadcast from all parts of Europe for the N.B.C.

In spite of the general belief that the greater part of the N.B.C. programmes consist of sponsored transmissions, only 19 per cent. are paid for by firms for publicity purposes. Seventy-nine per cent. are provided by the N.B.C. themselves for the benefit of their listeners.

The era of all-wave receivers begun at this year's Radiolympia will enable more listeners than ever to listen to N.B.C. programmes, which provide thrill, entertainment, education and really good music.

H. W. P.

Recent Inventions

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

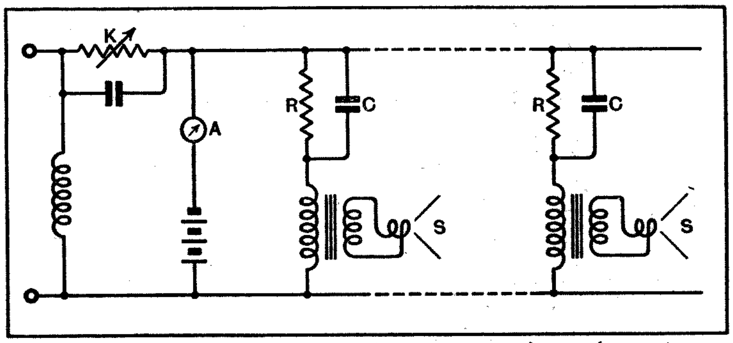
Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

WIRELESS RELAY SYSTEMS

IT is necessary in wired-wireless systems to know how many subscribers are taking the programme at any given time, so that the amplifier at the central station may be operated under the best conditions. Usually the working load or number of loud speakers in circuit is estimated by measuring the direct-current resistance of the line, but this method is not very accurate because the line resistance is comparable with that of the loud speaker itself, or of its transformer.

The difficulty is overcome by inserting in series with each loud speaker S, a high resistance R, which is "shorted" for audio currents by a condenser C, so that it does not affect the programme. The resistance is, however, thrown in parallel across the supply line, each time a subscriber switches on, and its effect is shown by an ammeter A, at the central station. A variable resistance K, which may be calibrated to show directly the number of speakers in circuit, is adjusted by the station attendant so as to maintain the ammeter reading always constant.

British Thomson-Houston Co., Ltd., G. S. C. Lucas, and E. S. Hall. Application date January 24th, 1935. No. 450863.



Method of monitoring and controlling the output in a relay system.

AUTOMATIC TUNING

THE shaft of the tuning condenser of a broadcast receiver is automatically swept over the whole of the frequency band by the moving core of an electromagnet which is energised from the mains or other source of supply. When a signal of "worth-while" strength is brought in, sufficient bias is applied to a control valve to arrest the movement of the driving-core and apply a brake. If the station so brought in is not the one desired, a remote control switch removes the bias and re-starts the tuning operation. The speed of the tuning condenser can be regulated, and also the level of signal-strength which will cause a station to be automatically tuned in. When the tuning condenser has made one complete rotation, the supply current which energises the driving electromagnet is momentarily cut off, and the condenser is then automatically restored by spring action to its starting position, ready to commence a second searching movement.

W. J. Bowman. Convention date (Canada) April 20th, 1934. No. 450472.

LOUD SPEAKERS

IN order to produce a single instrument having a response equivalent to the usual "dual" low-note speaker and a high-note "tweeter," a composite diaphragm is used of which the inner part is light and stiff, the outer part being less elastic and with considerable inherent damping. For instance, a thin, light piece of Bristol board is used to produce the "tweeter" effect, and is connected through a ring of felt or flannel to an extension piece of soft, dull and relatively heavy paper, which reproduces the lower notes. The connecting ring acts as a mechanical filter to damp out the higher frequencies and prevent them from reacting on the outer part of the cone. The inner part of the cone may be provided with a small additional "reversed" cone to emphasise the higher notes.

G. Birkbeck. Application date January 29th, 1935. No. 451178.

CATHODE-RAY TUBES

THE inside surface of a cathode-ray tube is coated with various layers which should not contact or overlap. For instance, there is a layer of fluorescent material at the large end of the tube, and also one or more conductive layers (of metal or graphite) arranged along the neck of the tube to serve as anodes or accelerating electrodes, or to afford a leakage path for stray charges of electricity.

According to the invention the glass bulb is made in at least two sections, one of which consists practically of the large end alone, whilst the other contains the gun part and the electrode assembly. The former is then readily coated with fluorescent material, whilst the latter is separately coated with silver or "aquadag." The two sections are afterwards fused together in such a way as to leave a slight peripheral "recess" which serves to keep the conductive coating, when this is "sprayed" on, within its proper limits.

Marconi's Wireless Telegraph Co., Ltd. (assignees of R. T. Orth). Convention date (U.S.A.) June 2nd, 1934. No. 451451.

CRYSTAL LIGHT-VALVES

A QUARTZ crystal is coated with metal by silvering or gilding, and line-gratings are scratched on its upper and lower surfaces. These act (*a*) as electrodes to which the signal voltage is supplied, and (*b*) as reflecting surfaces to control the amount of incident light which is either reflected back or transmitted through the crystal. In both cases the amount varies with the distorting action on the crystal of the applied signal voltage. In the region above the crystal, the applied voltage may cause a change from light to dark, by cutting-off more of the reflected light, whilst in the region below the crystal, there is a consequent increase in the intensity of the transmitted light.

I. G. Farbenindustrie Akt. Convention date (Germany) January 31st, 1934. No. 450686.

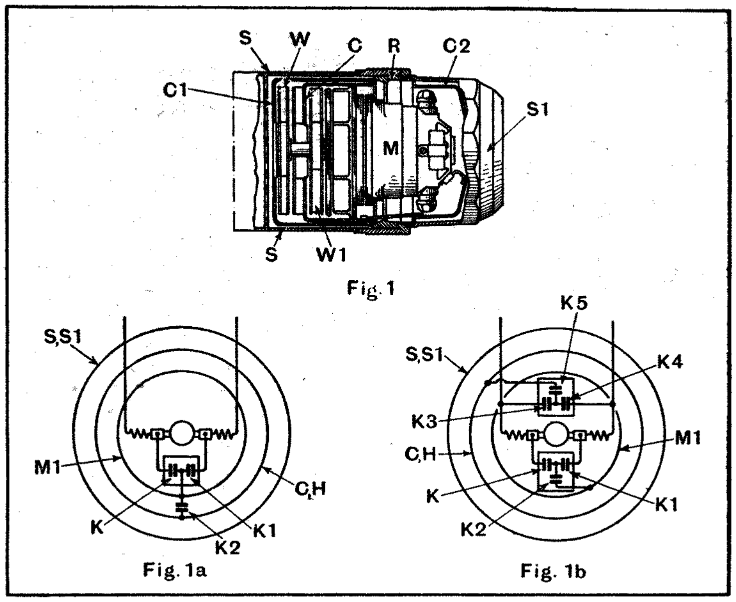
STATIC ELIMINATORS

FIG. 1 shows the motor M and impeller or fan-wheels W, W1 of the domestic type of vacuum cleaner. The motor unit, including the fan-wheels, is separated from the main casing C by a ring R of insulating material to which are connected caps or hoods C, C1, C2 surrounding the two fan-wheels and the rear part of the motor. The whole of this unit is electrically separate from the front and rear casing S, S1 of the cleaner.

Fig. 1 (a) shows a simple form of static-eliminator in which the brushes of the motor are shunted by two condensers K, K1 with a mid-point connection to the body M1 of the motor, and an extra condenser K2 between the motor and the three caps C, C1, C2 which are electrically connected. This latter assembly is represented by the circle C, H in Fig. 1 (a). The condenser K2 affords additional protection in case of contact between the motor and casing. An additional condenser may also be connected between the "cap assembly" C, H and the outer casing S, S1 of the vacuum cleaner.

Fig. 1 (b) shows a more elaborate arrangement in which the three condensers K, K1, K2 are supplemented by two other condensers K3, K4, connected in series and shunted across the field windings of the motor, the mid-point being connected through a condenser K5 to the "cap-assembly" C, H.

Electrolux, Ltd. (Assignees of Akt Elektrolux). Convention date (Germany), 3rd June, 1934. No. 450278.



Suppressing electrical interference in a vacuum cleaner.

AUTOMATIC SELECTIVITY CONTROL

THERE are several known methods of varying the selectivity of a set, whereby, in the absence of any interfering signal, the tuning is automatically broadened. This allows the HF circuits to accept more side-bands and so improves the quality of the programme being received. Usually the degree of "broadening" is made to depend directly upon the carrier strength of the received signal.

According to the invention the effective selectivity is controlled not by the carrier strength of the received signal alone, but by the ratio of its strength to that of any interfering carrier-wave which may be present.

The General Electric Co., Ltd., N. R. Bligh, and C. N. Smyth. Application date January 31st, 1935. No. 451227.

The Wireless World

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

CONTENTS

Editorial Comment

The Valve

Are There Too Many Types?

THIS week we present once more our annual issue containing a Special Valve Supplement, which gives in a concise form all the essential data required by the designer and user of valves in modern receivers. Each year the task of compiling this information becomes more exacting as the number of types increases, but just for this reason the information which is provided grows progressively in value to the user.

This year we have added to the data by including details of American type valves for the convenience of those who may own or be involved in servicing receivers of American manufacture.

Comparisons

The inclusion of American type valves in this supplement provokes a comparison between the formidable number of different types of valves manufactured in this country, as against the much smaller number in America. A study of the Valve Data Supplement will show that types in America have been standardised so that practically all manufacturers produce valves to agreed specifications, and as far as characteristics are concerned, valves of different makes are interchangeable.

In this country by contrast, however, each manufacturer has developed his own special types, and there is no interchangeability between any two manufacturers, except in the case of one or two isolated specimens. It will be seen that whilst all the requirements in the matter of receiving valves in America can be covered with some eighty types, there are here nearly ten valves of different characteristics for every one type produced in America. Surely such an arrangement is both inconvenient and wasteful, and perhaps contributes to a considerable extent to maintaining prices of valves here at a higher level than abroad.

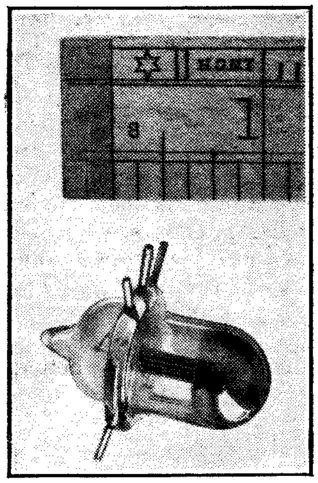
Since last year's Valve Supplement issue appeared, it has been our pleasure to record a substantial reduction in prices of British valves of many types, but there is still, we believe, room for further price reductions which in the long run would benefit the valve manufacturer by an increase in his output.

We have for a very long while urged that set designers should be encouraged to be more liberal with the use of valves in the design of receivers, because, as we have constantly reiterated in this column, the performance and probably also the reliability of receivers is dependent on the use of an adequate number of valves. There has for far too long been a tendency here to try to get the utmost out of every valve stage. This has encouraged valve designers to forsake a policy of standardisation in favour of trying to produce "super" types to meet the set manufacturers' demands.

Circumstances Have Changed

This attitude was probably fully justified in years gone by, when royalties amounting to 12/6 for each valve stage had to be paid by the set manufacturers, but to-day there is no penalty of this order for including additional valves and everything seems to point to the advisability of encouraging designers to employ a larger number and help the public to realise the advantages which a more generously valved receiver offers.

"Acorns" AND THEIR Applications



EFFECTIVE AMPLIFICATION AT ULTRA-SHORT WAVELENGTHS

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

IT is often left to be supposed, or it is even actually stated, that the secret of the efficiency of the "Acorn" type of valve at ultra-high frequencies is its low inter-electrode capacity. It is true that a reduction in capacity is helpful, but if the facts are considered there is no difficulty in seeing that this explanation of the "Acorn's" superiority is not the most important one.

Compared with the "midget" type of valve, the inter-electrode capacities are less by only about 1 m-mfd. But effective amplification is possible with the "Acorn" at something like five times the frequency. Even when compared with standard full-size types of valve, the extension in performance is out of proportion to the reduction in capacities. And the important anode-to-grid capacity that is usually the limiting factor in RF amplification by screen-grid tetrode or pentode types of valve is no smaller in the "Acorn" than in most other kinds.

The less obvious, but more important, factor in the matter is a serious form of loss that exists when the time taken by the electrons to cross the space inside the valve is not negligible compared with the time of one complete oscillation. At a frequency of 100 Mc/s (wavelength of 3 metres) the time occupied by one oscillation is, of course, one hundred-millionth of a second; and for a valve to work effectively it must be designed so that the "transit time" is a very small fraction even of this brief moment. In ordinary valves this condition is not fulfilled; and, while one would expect as a result some interference with the regular mode of operation, it is certainly not obvious that it has the effect of reducing the input resistance of the valve—ordinarily of the order of a megohm—to a few thousand ohms.

THIS article explains why the recently introduced miniature valves known as "Acorns" can be operated effectively at wavelengths much lower than is possible with ordinary types; methods of using the valves to the best advantage are also discussed.

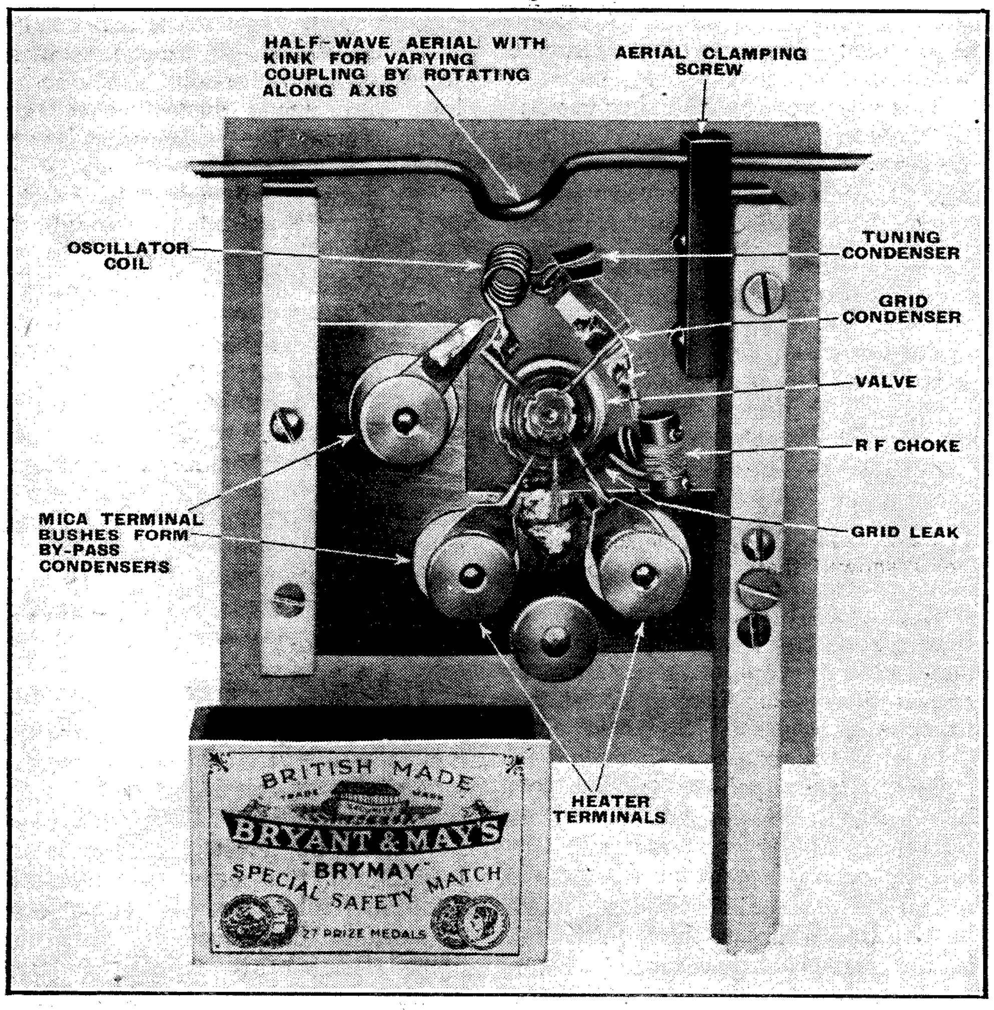


Fig. 1.—Arrangement of ultra-high-frequency transmitter employing "Acorn" triode. Note metal base forming one plate of all by-pass condensers.

The connection between this effect and its cause is explained in a recent article,[1] which also gives the results of some measurements made on valves at ultra-high frequencies. The sort of result one gets at, say, 60 Mc/s (5 metres) is 5,000 ohms for the input resistance of an ordinary valve and 25,000 ohms for an "Acorn." At the former figure a tuned input circuit is to a large extent short-circuited; at the latter a very useful amplification is possible.

"Centimetre" Wavelengths

As a matter of fact, amplification at a frequency as high as 430 Mc/s (0.7 metre) is claimed for the "Acorn." When the input resistance of a valve, expressed as a *conductance,* is equal to the mutual conductance no amplification is possible, even theoretically. Thus, if the mutual conductance of the valve is 1.25 milliamps. per volt, equivalent to 800

[1] "Grid Loss at Ultra-High Frequencies," *The Wireless World,* October 23rd, 1936.

"Acorns" and their Applications—

ohms resistance, there is no use attempting to amplify if the input resistance is no greater. In practice, in order to allow for circuit and other losses, a considerably higher figure is necessary.

The point to notice about this is that there would be no advantage in raising the input resistance of a valve if at the same time the mutual conductance were dropped in similar proportion. Fortunately the reduction in electrode spacing necessary to achieve the former object tends to produce a better mutual conductance; or at any rate to offset the loss that would otherwise be caused by reducing the surface areas of the electrodes.

The race for higher and higher valve conductances has already brought the spacing of electrodes as close as is at all practicable for mass production; the still smaller clearances necessary to achieve the performance of the "Acorns" necessitate very delicate hand construction, and correspondingly high cost. The complete cathode, with insulated hairpin heater inside, is no thicker than an ordinary pin; and the clearances between electrodes are as little as a two-hundredth of an inch. So, although their small dimensions and lively all-round characteristics render "Acorns" attractive for many purposes, economic reasons confine them to applications where no others will do—namely, ultra-high-frequency work.

Those listed at the moment include the Mullard AP4 pentode, which, except for

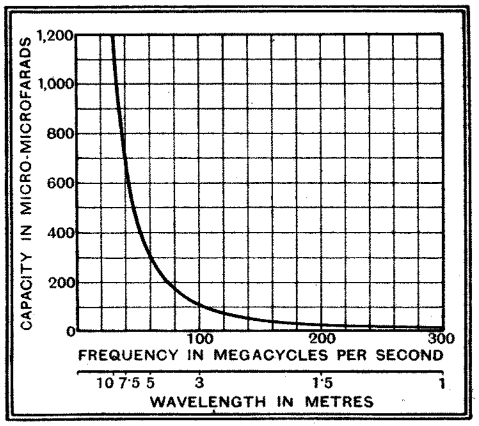


Fig. 2.—Optimum capacity of by-pass condensers, assuming that the total length of connections (including the condenser electrodes themselves) is about one inch.

the 4-volt heater, is similar in rating to the R.C.A. 954 (imported by Messrs. Claude Lyons). Triodes are made by Mullard (AT4), R.C.A. (955), and Osram (HA1). Mazda produces two types: the A40 triode and the A41 pentode.

Elsewhere in this issue are given tabulated characteristics which, it will be seen, are in most respects comparable with those of any ordinary valves of corresponding type; in fact, except for the somewhat lower inter-electrode capacities, it is difficult to discern anything special about them. All are indirectly heated, but need not for this reason be considered for mains drive exclusively; the heater current ratings are from 0.15 to 0.3 amps., which makes no excessive demand on even a small accumulator.

The "Acorn" pentode is capable of giving an amplification of at least 3 at a wavelength of one metre. For signals in the television waveband—for example, for

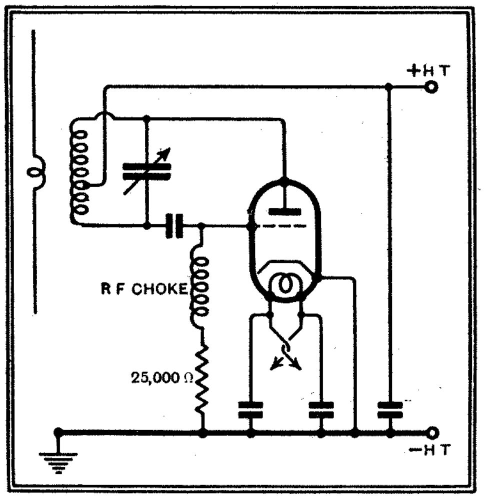


Fig. 3.—Circuit diagram of oscillator shown in Fig. 1.

a stage of amplification ahead of the frequency-changer—a considerably larger gain is possible, whereas with ordinary valves it requires very careful design and arrangement to get any amplification at all.

To derive the full benefit of the "Acorn" construction one must, of course, arrange the circuits to suit. Special holders are obtainable, made of low-loss ceramic material and designed to avoid unnecessarily prolonging the leads to the valve. Incidentally, the makers warn users of the valves not to attempt to minimise the length of leads by soldering them direct to the valve contact wires, as this would probably crack the glass and destroy the vacuum.

By-pass condensers for ultra-high-frequency circuits ought to be "good" in the electrical sense, and connected as close up to the valve and oscillatory components as possible. One way of doing this is to mount the apparatus on a thick sheet of copper, which forms the "earth" and one side of all by-pass condensers, as illustrated in Fig. 1.

In a *Wireless World* article some years ago[2] I showed that there is no point in making by-pass condensers too large; in fact for each frequency there is an optimum capacity which just balances the inductance of the connecting leads and of the condenser itself, thus giving a lower impedance even than an infinitely large condenser. On the assumption that the inductance within and without the condenser is equal to that of one inch of straight wire, the graph (Fig. 2) gives the optimum condenser capacity for any frequency in the ultra-high band. In any particular case the inductance may differ considerably from that assumed, but when the connections have been reduced to a minimum the graph is a useful guide to the order of magnitude of capacity needed. It is advisable to select the capacity on the basis of the lowest frequency at which the circuit is to work. Too much capacity is better than too little.

[2] "By-Pass Condensers for 5-Metre Work," *The Wireless World*, September 29th, 1933.

The RF parts of the circuit may be isolated by chokes. For not more than a few metres, 15 turns of 30 DSC wire on a ¼-in. ebonite or glass tube is suitable.

The circuits themselves may be more or less standard, as Fig. 3 exemplifies. This is the circuit diagram corresponding to Fig. 1, which is a picture of a low-power transmitter working on a wavelength of 80 cms. It can readily be seen that it does not make extensive demands on space. I hope to be able to give some account of this transmitter and the corresponding receiver, and the results obtained therewith, in a subsequent article.

For Miniature Transmitters

It will be recalled that for a stunt by the N.B.C. in America a miniature transmitter embodying an "Acorn" was mounted, complete with half-wave aerial, on the top hat of the announcer, who interviewed passers-by on the street and radiated their remarks so that they could be relayed by the broadcasting stations.

In oscillator circuits the "Acorn" triode functions right up to about 750 Mc/s (0.4 metre). Since a half-wave aerial, or dipole, for this frequency is only 8 in. long, the scope for miniature transmitters with good radiating properties is clear. The power output above 300 Mc/s is small, but is effective for communication over several miles so long as intervening obstructions do not cause excessive screening. At 60 Mc/s (5 metres) the output in a Class "C" (over-biased) oscillator circuit may be as much as half a watt, with an input of 8 mA at 180 volts.

Naturally, an "Acorn" triode can be

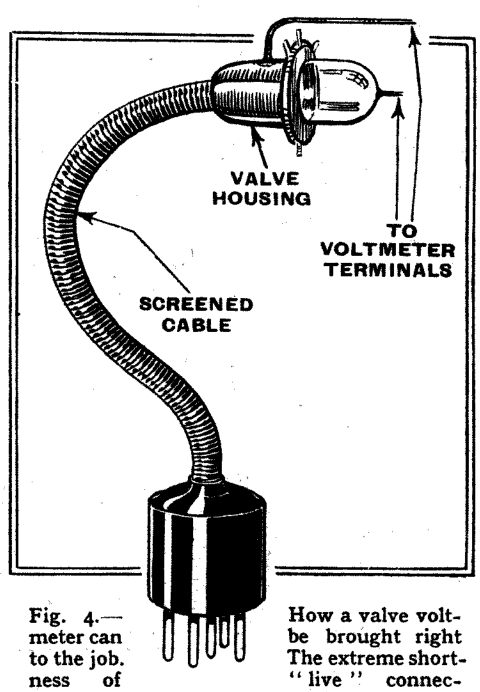


Fig. 4.—How a valve voltmeter can be brought right to the job. The extreme shortness of "live" connections makes it very suitable for ultra-high-frequency work.

"Acorns" and their Applications—

used in a conventional reaction receiver circuit; but it is extraordinarily difficult to "find" any particular signal, and having found it to keep it. A super-regenerative circuit gives enormously greater sensitivity and much less critical tuning; the higher the frequency the easier it is to operate, and it is the obvious system to use for reception at extremely high frequencies.

At the lower frequencies, such as the television and 5- and 10-metre amateur bands, substantial amplification is obtainable with the "Acorn" pentode. It should be mounted in a circular opening in a metal baseplate or screen, so as to separate the input and output sides of the stage of amplification in the manner of the early SG valve amplifiers.

Although there is not much published information on the subject, there seems to be no reason why the "Acorn" pentode should not be advantageously used as a mixer valve in conjunction with a separate oscillator in a superhet. For television frequencies the benefit of higher input impedance might not be worth the much greater valve cost, but at the very highest frequencies it is difficult to see what other valve could be used for the purpose.

A useful application, not only at very high frequencies, is in a valve voltmeter. By mounting the valve at the end of a flexible metal tube it can be brought right up to the work, and the input impedance is much higher than usual. Fig. 4 shows the general idea, and Fig. 5 is a circuit recommended by the R.C.A. The 954 pentode with the electrodes connected to give a triode is specified, presumably to take advantage of the convenient grid "spike," but, of course, the 955 triode or its equivalent can be used for the purpose, and is to be preferred as being a more reliable valve.

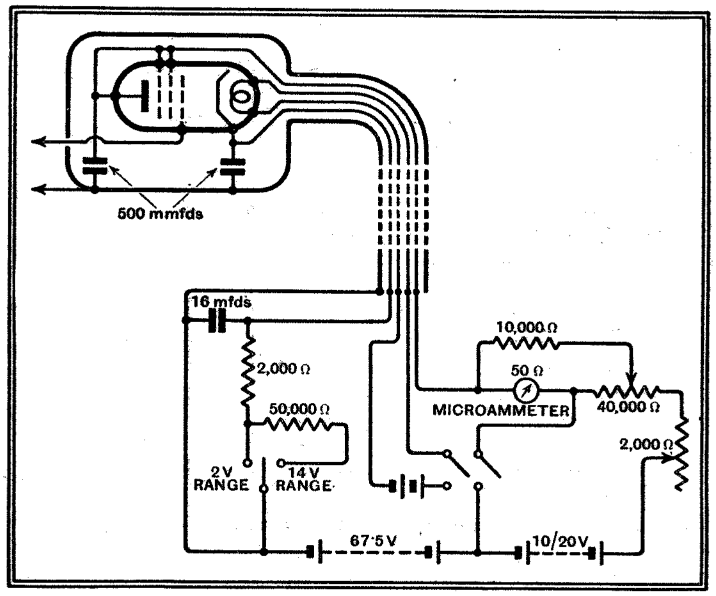


Fig. 5.—Circuit of valve voltmeter, due to Radio Corporation of America.

DISTANT RECEPTION NOTES

THERE is some fine 'phone or loudspeaker fodder from the other side of the Atlantic awaiting those dyed-in-the-wool D-Xers who despise anything rated at over 100 watts and don't mind getting up with the lark on the chilliest of mornings when it's a question of "bagging" rare stations. For the purpose of frequency checking the U.S.A. Federal Communications Commission requires certain low-powered stations, which in the ordinary way work on common wavelengths, to give 20-minute broadcasts after normal working hours on the second Monday, Tuesday, Wednesday, Thursday, Friday and Saturday in each month. For these transmissions the selected stations have the channels to themselves and give their code signs every three minutes. Here, then, is a heaven-sent opportunity of logging these transatlantic tiddlers.

The Monday list, times being in G.M.T., is: 7 a.m., WLNH, 100 watts, 228.9 m.; WJBO, 100 watts, 211.1 m.; 7.10, WBRB, 100 watts, 247.8 m.; WHBB, 100 watts, 200 m.; 7.20, WMAS, 100 watts, 211.1 m.; WIOD, 1,000 watts, 230.6 m.; 7.30, WWRL, 100 watts, 200 m.; WJBW, 100 watts, 250 m. On Tuesday: 7 a.m., WBAX, 100 watts, 247.8 m.; 7.10, WDAS, 100 watts, 218.8 m.; 7.20, WBBL, 100 watts, 247.8 m.; 7.30, WFBG, 100 watts, 228.9 m. On Wednesday: 7 a.m., WMFJ, 100 watts, 211.1 m.; 7.10, WAIM, 100 watts, 250 m.; 7.20, KVOL, 100 watts, 228.9 m.; 7.30, WHBQ, 100 watts, 218.8 m. On Thursday: 7 a.m., WSVS, 50 watts, 218.8 m.; 7.10, WKOK, 100 watts, 247.8 m.; 7.20, WRAW, 100 watts, 228.9 m.; 7.30, WOCL, 50 watts, 247.8 m. On Friday: 7 a.m., WGNY, 100 watts, 247.8 m.; 7.10, WCNW, 100 watts, 200 m.; 7.20, WGBB, 100 watts, 247.8 m.; 7.30, WABY, 100 watts, 218.8 m. On Saturday: 7 a.m., WMFR, 100 watts, 250 m.; 7.10, WMFO, 100 watts, 218.8 m.; 7.20, WSOC, 100 watts, 247.8 m.; 7.30, WTJS, 100 watts, 228.9 m.

Well, there's a nice possible bag to be going on with. And if anyone logs the complete tale on any morning he'll have earned his breakfast, for which, no doubt, he'll have an excellent appetite! The list I have given is not complete, for the check actually goes on for four solid hours on each day. It is hardly likely, though, that such small stations will be heard over here much after 7.30 a.m. even in the depth of winter. I must apologise for including such a giant as the 1,000-watt WIOD; it just happens to be there!

What an excellent idea this official check is. It means that every common-wavelength station in the States is put through its paces against a precision wavemeter once a month. What wouldn't the I.B.U. give for the chance of doing the same thing with European stations!

A kind London reader tells me that he heard Klaipéda regularly during the summer, finding it as strong as Athlone, if not stronger at times. He tells me, too, that there are quite a few 10-kilowatt Russians that don't appear in the lists that are available in this country. Here are a few that should be worth logging: Stalino, 776 kc/s; Ordjonokize, 752 kc/s; Samara, 713 kc/s; Kazan, 686 kc/s; Ivanovno, 668 kc/s; Murmansk, 610 kc/s.

A Forfarshire reader, to whom my best thanks, tells me that the new Rennes transmitter is responsible for bad sideband splash when the Scottish National is being received. Curiously enough, the unwanted Rennes can be brought in without any splutter from the Scottish National. Caledonia, for this reason, is stern and wild.

D. EXER.

Television Programmes

The principal items only of each day's programmes are given. The system to be used each day is given below the date. Transmission times are from 3-4 and 9-10 p.m. daily.

Vision 6.67 m. (45 Mc/s). Sound 7.23 m (41.5 Mc/s).

FRIDAY, NOVEMBER 20th.
(Baird.)

3.5, Laundry Demonstration: Ironing. **3.20,** Film. **3.30,** Vivienne Brooks and the Television Orchestra. **3.50,** Movietone Magic Carpets: Fisherman's Fortune.

9.5, Laundry Demonstration: Ironing. **9.20,** Movietone Magic Carpets: Land of the Nile. **9.30,** Cabaret. **9.50,** Film.

SATURDAY, NOVEMBER 21st.
(Baird.)

3.5, Autumn Pruning: C. H. Middleton. **3.20,** Film. **3.35,** Starlight: Claude Dampier. **3.50,** Movietone Magic Carpets: Fisherman's Fortune.

9.5, Autumn Pruning: C. H. Middleton. **9.20,** Film. **9.35,** Edward Cooper: Songs at the Piano. **9.50,** Movietone Magic Carpets: Land of the Nile.

MONDAY, NOVEMBER 23rd.
(Marconi-E.M.I.)

3.5, Ernest Mills: Lightning Cartoonist. **3.15,** Movietone Magic Carpets: Diamonds in the Rough. **3.30,** Scenes from "The Tiger," with William Devlin as Clemenceau.

9.5, Model Theatre. **9.15,** Movietone Magic Carpets: Happy Days in the Tyrol. **9.30,** Scenes from "The Tiger."

TUESDAY, NOVEMBER 24th.
(Marconi-E.M.I.)

3.5, Sheepdog Trials. **3.25,** Film: Happy Days in the Tyrol. **3.40,** Starlight: The Western Brothers.

9.5, Fencing Demonstration. **9.30,** Film: Diamonds in the Rough. **9.45,** Cabaret.

WEDNESDAY, NOVEMBER 25th.
(Marconi-E.M.I.)

3.5, Film: Diamonds in the Rough. **3.15,** Film: Happy Days in the Tyrol. **3.30,** Picture Page.

9.5, Repetition of Afternoon Programme.

THURSDAY, NOVEMBER 26th.
(Marconi-E.M.I.)

3.5, Allied Arts and Handicrafts Exhibition. **3.30,** Film: Happy Days in the Tyrol. **3.45,** Starlight: Lou Holtz.

9.5, Allied Arts and Handicrafts Exhibition. **9.30,** Film: Diamonds in the Rough. **9.45,** Irene Prador.

In Other Fields

Valves and Gas-filled Relays in Science and Industry

By F. E. HENDERSON, A.M.I.E.E.

(Osram Valve Dept., The General Electric Co., Ltd.)

ALTHOUGH in the eyes of the man in the street the thermionic valve is probably associated almost entirely with the science of radio communication—hence the common term "wireless valve"—it is appreciated in technical circles that the limitations of its application by no means end with this field. In spite of this, few except specialists, realise how many types of valves have appeared during the past few years, incorporating designs aimed principally at the industrial or laboratory application.

The versatility of the modern thermionic valve, and the improvements in cathode technique, methods of obtaining high vacua and high insulation, and experiments in gasfilling, offer an ever-expanding scope for the ingenuity of electrical engineers and scientists.

A great deal more attention has been paid in America to the applications of valves in industry and science than in this country, and surveys have been issued for a large number of practical applications, many of which are in actual daily use.[1]

A brief review of some of the types of British-made valves which have recently been introduced for such purposes may therefore prove of interest.

Although not coming within the category of a thermionic valve, the photoelectric cell as an electron-operated device is rapidly becoming recognised as an invaluable tool, not only to science, but to industry of all kinds. This article is not, however, intended to deal with the applications of photoelectric cells, but to describe some types of thermionic valves in the proper sense. These may be roughly divided into two groups: the hard vacuum group, and the gasfilled group.

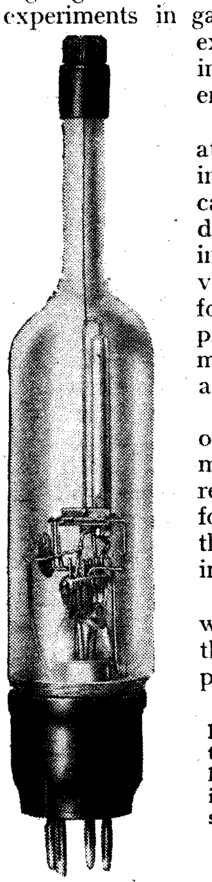


Fig. 1.—The electrometer triode has an extremely high input impedance, and is designed for use as a substitute for electrostatic measuring instruments.

1 See *Electronics*, January, 1935.

Hard valves are necessarily limited in their power-handling capacity by the electron emission of their cathodes, and in their efficiency by their internal impedance, and their use would therefore be expected to be restricted to scientific instruments for measurement or detection of electrical energy well within the capacity of the electron emission, or for use as rectifiers or in amplifiers for operating either visual or sound reproducing mechanism.

Apart from valves developed for use in amplifying equipment, some examples of hard valves developed for scientific instrument use are: electrometer triode, valve voltmeter triode, peak voltmeter diode, and the ultra-short wave oscillator of the split-anode Magnetron type.

The electrometer triode, illustrated in Fig. 1, was first developed towards the end of 1930, and has proved of value to many workers in laboratories and factories for the accurate measurement of electrostatic potentials and very small electric currents. The chief characteristics of the electrometer triode is its extremely high value of grid-cathode impedance. In standard types of triode, as used in radio receivers, the grid-cathode impedance may reach a value of 10^9 ohms, but seldom exceeds this value, so that such valves could not be employed to replace electrostatic instruments. The electrometer triode was designed with a view to removing this limitation, and in the type illustrated, the insulation resistance between grid and other electrodes is greater than 10^{17} ohms. It has also been found possible in this valve to reduce the total residual grid current to less than 10^{-15} ampere, while retaining reasonable sensitivity. At 1,200 kc/s the input impedance exceeds 100 megohms.

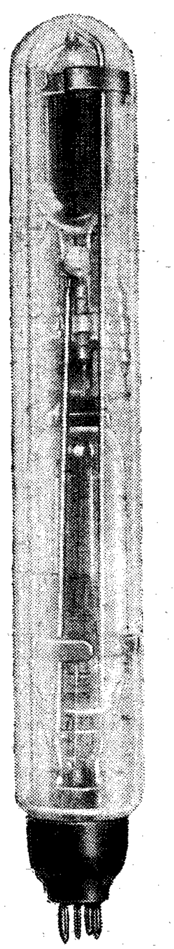


Fig. 2.—For photometry of lamps: an electrometer triode combined with a standard photo-cell.

These features are achieved by mounting the control electrode, or grid, in the form of a flat plate supported from two pillars of special high-resistance glass, the grid lead being taken to a terminal through the end of a stem also of high resistance glass, and sealed to the top of the bulb. The anode and filament are mounted on a glass pinch which supports the two pillars. In the glass used for the bulb and stem in the electrometer triode care is taken to ensure low surface leakage, unaffected by exposure to the atmosphere over long periods.

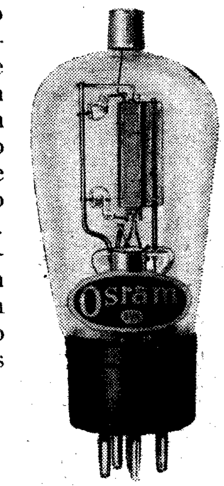


Fig. 3.—A valve voltmeter triode, with high input impedance at radio frequencies.

Ensuring Stability

A further precaution is taken to ensure that the getter surface does not spread over the upper portion of the bulb and the grid insulating pillars. Internal and external guard rings are provided, connected to a pin in the base of the valve. The guard rings and getter surface are arranged to be maintained at earth potential, thus obviating the risk of stray charges accumulating on the glass, and ensuring stability of characteristics. The advantages of this valve over the more usual form of electrometer are comparative robustness, low input capacity and greater sensitivity and stability.

The electrometer triode may be used in several ways[2] for the measurement of every small charges and currents, such as photoelectric or ionisation currents, or high resistances. Thus electrostatic potentials of from 0.1 millivolt to 6 volts may be directly determined. A practical application is in conjunction with a photoelectric cell for accurate photometry of lamps. To meet such a case a special tube has been developed, combining the

2 Warren, *G.E.C. Journal*, 6-2 (1935).

In Other Fields—

electrometer triode and a standard photocell with a grid coupling resistance, mounted together in an evacuated glass bulb (Fig. 2).

Another important application is the

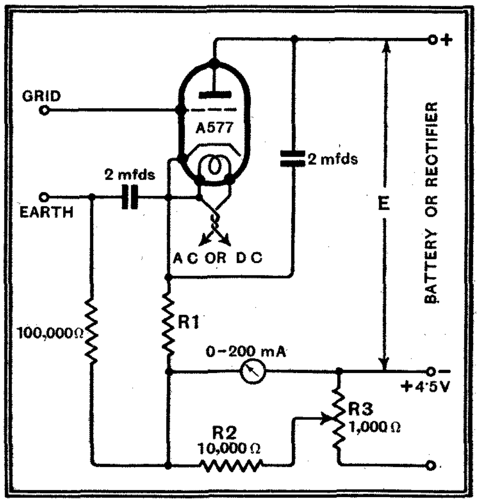


Fig. 4.—A typical valve voltmeter circuit. R1 and R2 constitute the backing-off circuit, with zero adjustment on R3. Suitable operating conditions for various voltage ranges are given in the accompanying table.

RMS Voltage Range	0—5	0—15	0—50	0—100	0—150
Supply Voltage E (anode + bias)	35	75	270	270	270
Bias Resistance R_1 ...	13,000 ohms	60,000 ohms	250,000 ohms	550,000 ohms	800,000 ohms

measurement of glass electrode potentials in the determination of hydrogen-ion concentration values; also the determination of high resistances and for the study of the piezo-electric effect in crystals.

The valve voltmeter triode, as typified in Fig 3, which shows Type A577, is a valve having more or less standard amplifier triode characteristics, but designed to exhibit an extremely high input AC resistance at high frequencies.

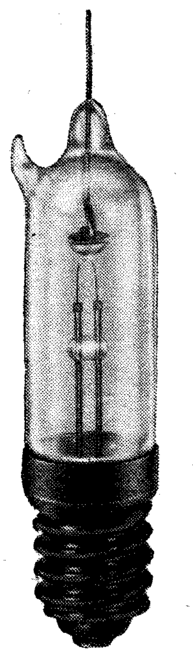


Fig. 5.—A peak voltmeter diode. Type A373.

The A577 valve consists of an indirectly heated triode system showing a mutual conductance of approximately 2 mA/volt, but with the grid support wires held by means of two separate glass beads so disposed as to afford a much higher insulation resistance than if the grid were mounted on a pinch in the ordinary way. This construction would render the valve unsuitable for use in amplifiers owing to microphony, but is essential for its particular application for purposes of measurement.

In addition, the grid connection is taken to the end of the bulb remote from the other electrodes. In this type of valve the input AC resistance as measured on a cold valve at one megacycle is approximately 20 megohms.

The principal application of this valve is in a mains-operated or portable valve voltmeter in which the valve operates as an anode bend rectifier and may cover a wide range of voltages when operating at high frequency. A typical circuit diagram illustrates its use as shown in Fig. 4, and such an instrument can be arranged to include the measurement of voltages at all frequencies within the normal radio and audio range.

To meet the laboratory need for a direct reading peak voltmeter to operate on frequencies up to about 100 megacycles/sec., the small directly heated diode illustrated in Fig. 5 (Type A373), has been developed. This valve is of small dimensions and operates from a 2-volt filament supply, being capable of use with a peak anode voltage of 2,000 at frequencies up to 50 megacycles, or 1,500 volts at frequencies up to 100 megacycles.

The valve employs a short filament system with an anode supported at the remote end of the bulb, the anode connecting wire projecting to carefully defined length beyond the end of the bulb. This valve is so designed that the input capacity is very low (about 0.5 m-mfd.)

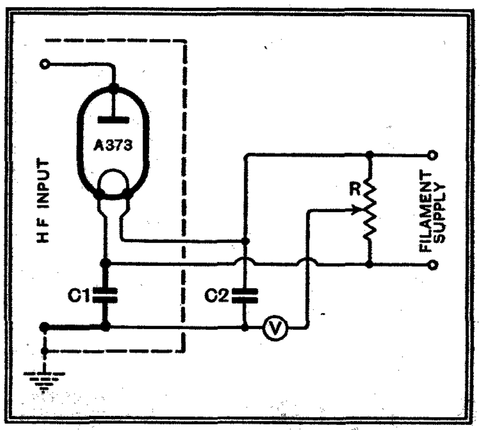


Fig. 6.—Illustrating the use of a special diode for measuring peak voltages. The filament supply must be insulated from earth by at least 500 megohms. C1, C2, 0.001 mfd. for any radio frequency; R, 100 ohms, centre tapped; V, electrostatic voltmeter or equivalent.

in spite of a very small anode-filament clearance.

Fig. 6 illustrates a suitable circuit with Type A373 arranged for high-frequency voltage measurement. For such purposes it is normal to employ an earthed screening case around the RF part of the instrument and an insulation resistance of not less than 500 megohms between the filament and earth.

Another important application is the measurement of modulation characteristics, for which the diode is used in conjunction with a cathode-ray oscillograph.

With the increasing technical interest in oscillations of ultra-short wavelength, the limitations of the more common triode circuits in producing, amplifying and detecting such oscillations has led to the development of other methods. The principal limitations arise from the inter-electrode capacities and the electrode lead inductances, and also from the transit time of the electrons in their path.

The type of valve which has been developed to reduce the effect of these limitations is known as the split anode Magnetron and a full description of the construction and operation of such valves has been given elsewhere.[3]

Fig. 7.—Construction of a split anode Magnetron, as used at extremely high frequencies.

The split anode Magnetron is of increasing interest to investigators employing ultra-high frequency circuits. This range may be taken as representing wavelengths lying between 10 metres and 1 centimetre, it being estimated that the practical wavelength limit of conventional triodes is about 1½ metres as an oscillator or amplifier, and rather lower for detection. The split anode Magnetron, illustrated in Fig. 7, which shows type CW10, consists of an emitting cathode contained within an anode divided into two equal segments separated by narrow gaps, each segment being carefully insulated from the other. The valve operates in a magnetic field with the electrode axis approximately parallel to the lines of force. When under the influence of this field the electrons in their passage to the positive anode experience the deflecting force and, at a certain critical value of anode voltage and field strength, they will cease to reach the anode. This principle is applied in the Magnetron to impart a range of negative resistance to the valve similar in form to the dynatron characteristic arising from secondary emission in a tetrode. If a tuned circuit is connected between the anode segments and the high tension supply, oscillations can be produced and maintained at exceedingly high frequency.

Wavelength and Output

In the CW10 valve electronic oscillations may also be produced at wavelengths between 22 and 50 cms, and the type is designed to operate normally at an anode voltage up to 1,000 volts with a dissipation of 50 watts. The output ranges

[3] Megaw—*Journal I.E.E.*, Vol. 72, p. 326, 1933.

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from 10 watts at 1.2 metres' wavelength to 30 watts at 3 metres. The possible output increases with both anode voltage and filament emission, provided the magnetic field strength is increased with the anode voltage. For a given anode voltage the behaviour of the circuit can be entirely controlled, apart from wavelength adjustment, by means of the filament and field current rheostats. Using the electronic type of oscillation generator, an output of 2 watts is obtained at a wavelength of 25 cm.

Other types of split anode Magnetron are:

Type CW11, which is principally intended for dynatron oscillations at wavelengths of 1 to 5 metres.

Type E639, which is made with four anode segments allowing alternate wavelength ranges of from 0.5 to 1.5 metre with an output of 20 to 40 watts, and 1.5 to 5 metres with an output of 20 to 50 watts.

The field of micro-wave oscillations is one which is largely unexplored and hence the use of the split anode Magnetron is at present restricted to investigation by workers in the fields of both radio communication and medicine. This type of valve may ultimately be employed for point-to-point working on short-distance radio communication circuits or for radio beacons. The detection of moving objects ("wireless searchlight") is also an important possibility.

Workers in the medical field may discover new and promising possibilities in production of local heating, study of bacteria, etc.

(To be concluded.)

Current Topics

Events of the Week in Brief Review

British Sets Praised in America

WE hear so frequently of the alleged superiority of American receivers that it is very refreshing to read in an American wireless magazine an article in which high praise is given to British sets exhibited at this year's Radiolympia, and the hope expressed that in a year or two's time American listeners may be able to have receivers equal to those on the British market.

More Anti-fading Aerials

THE success attending the single-mast type of aerial which acts as the energy radiator, its base being insulated, is leading to its adoption by a large number of European stations, the latest being Beromunster. It is reported, also, that the Estonian broadcasting authorities are considering the adoption of this type of mast for all their stations.

German Television

ACCORDING to reports received from Germany, work has been started on the two television stations on the Brocken Mountain and on the Feldberg Taunus near Frankfurt. At Brocken the building will be a fourteen-storey "tower" one of granite and concrete, and it is hoped to complete it by next winter. A site has been purchased for the other station, although building operations have not yet actually started.

The P.M.G.'s Good News

IT is refreshing to learn from no less an authority than the P.M.G. that the Government are giving very careful attention to the report made by the committee which was set up to consider the question of electrical interference to broadcast reception. The P.M.G. stated that an early announcement might be expected concerning the Government's policy in this matter.

According to the same authority, an early start is being made in carrying out the laying of a concentric "television" cable between Birmingham and Manchester. The London to Birmingham cable is already completed, and will deal with a 2-megacycle frequency band. It is planned eventually to cover the country with these special cables to link up the various television stations which it is intended to erect.

"W.W." and German Text Book

THE first comprehensive book on the superhet. written in the German language has just made its appearance in Berlin. It is noteworthy that at the end of the book the author indicates that in deriving his information he has only used two sources other than German, and one of these is *The Wireless World.*

Cathode-Ray Tube Lectures

A SPECIAL course of eight lectures on the cathode-ray tube and its applications is to be given at the Regent Street Polytechnic by Mr. G. Parr of the Radio Division of the Edison Swan Electric Co., Ltd. These lectures will take place on Mondays from 8.30 to 9.30 p.m. commencing on November 23rd, and the fee for the course is 10s.

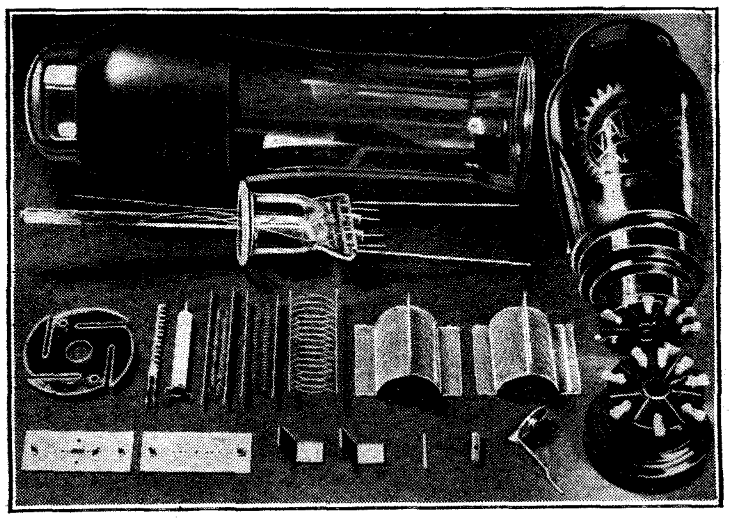
America's Wireless Expenditure

NEARLY a quarter of a million pounds is to be spent by the U.S. War Department on radio equipment during the ensuing year. America is also to spend £100,000 on radio beacon equipment. In view of this large expenditure on radio it is interesting to note that during the past year America only spent £4,000 on foreign radio apparatus, over half of this money going to Germany. The share of this country in American radio imports was £1,300.

Interesting Trade Figures

THE twenty-ninth report of the Imperial Economic Committee, which was published on November 9th, consists of a survey of the world's trade in electrical apparatus, including, of course, wireless. It is extremely interesting to note from this report that wireless apparatus now accounts for no less than one-quarter of the value of world trade in electrical equipment. It appears that the estimated number of wireless receiving sets in use throughout the world at the end of 1935 was 56 million. This represents an increase of between 60 and 75 per cent. over a period of four years. The United States and Europe (excluding Russia) account for some 85 per cent. of this figure.

Ninety per cent. of the wireless trade is concentrated in the hands of four countries. Of these, the two leading countries, the U.S.A. and Holland, account for about two-thirds of the trade. Germany is third, and this country, which is responsible for about one-tenth of the trade, is fourth. It appears that the Empire takes only about one-third of the total exports of this country, our biggest customer being Holland. By far the largest part of our wireless exports consists of transmitting apparatus and valves, the majority of these valves being of the transmitting type.



NEW OUTPUT VALVE FOR HIGHER QUALITY. The component parts and a fully assembled Philips-Vahre AL4 valve, a 9-watt pentode that has recently appeared on the Continental markets.

New Swedish 100-kilowatt Station

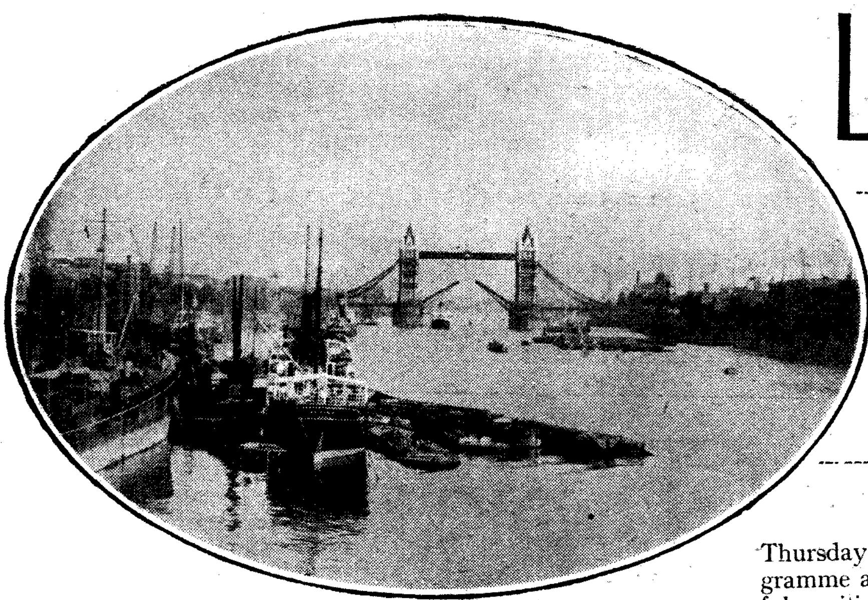
SOME time during the early part of next summer we should be able to hear the transmissions from the new 100-kilowatt transmitter that is going up at Linderodsasen, near Horby, in the South of Sweden. This station is being built on a site about 500ft. above sea level, and the top of the aerial mast will be almost 400ft. above this. For this reason an exceptionally good range is anticipated.

Aircraft "Q" Code

AN Air Ministry Notice to Aircraft Radio Operators (No. 6, 1936) contains a number of important amendments to the "Q" code, both in the way of alterations to the existing meanings of abbreviations and the addition of new groups. Air Publication 1,529 is affected.

Listeners' Gui

Outstanding Broadc



TOWER BRIDGE which is featured in a special outside broadcast on Thursday seen from London Bridge. A steamer, as she passes the bridge bound for the Baltic, will also come into this programme.

IT is fitting that so near Christmas a special programme should be put on the air dealing with the past history and present efficient activities of the service on which we rely so much at this festive season—namely, the G.P.O. In this programme, "Post-Haste," compiled by George Wright and H. L. Morrow, which will be produced by Felix Felton to-night (Friday) at 8.10 (Nat.) and to-morrow at 3 (Reg.), the milestones in the development of this public service during the past three hundred years will be recounted. The sound picture of the postal service of to-day will give listeners an insight into the many activities of the G.P.O. in its home in St. Martin's-le-Grand, in the shadow of St. Paul's Cathedral.

MUSIC

FROM the fourth Symphony Concert in the Queen's Hall on Wednesday, Egon Petri will be heard playing the Beethoven Pianoforte Concerto No. 4. Also in this concert will be heard Berlioz's Overture, "Les Francs Juges," Debussy's "Nocturnes" in which the B.B.C. Women's Chorus takes part, and Sibelius' Fifth Symphony. For the first time Leslie Heward will conduct the B.B.C. Symphony Orchestra. The works of Berlioz, Beethoven and Debussy are included in the first part to be broadcast at 8.15 and that of Sibelius in the second at 9.50, both on the National wavelength.

Details of the week's Television programmes will be found on p. 524.

To-night (Friday) at 7.45 (Reg.), George Dyson conducts the Belfast Philharmonic Society's performance of his choral work, "The Canterbury Pilgrims," in the Ulster Hall, Belfast.

Sunday, November 22nd, is St. Cecilia's Day, and every year in honour of St. Cecilia, the patroness of music, special festivals are held on that day. From the Leeds studio will be broadcast a special concert in her honour at 5.20 Nationally.

Continental relays are now becoming a weekly occurrence, and this week the Polish Broadcasting Orchestra and Chorus will be heard Regionally on Sunday at 6 from Warsaw in "Les Noces," an orchestral and choral work by Roman Palester and Leon Schiller.

TOWER BRIDGE

A SOUND picture of activity in the Pool of London and on Tower Bridge will be presented by the "O.B." department on Thursday in the National programme at 9.40. By the careful positioning of microphones it is hoped to give listeners a true picture at the bridge when the passage of road traffic is interrupted for the two sections of the bridge to be raised to allow an outward-bound steamer to pass down the river.

REVIVALS

THREE revivals come into the current week's programmes. The first will be on Sunday, when Oscar Wilde's sparkling comedy, "The Importance of Being Earnest," will be given to National listeners at 9.5. Ronald Squire plays the part of Ernest, and others in the cast include Mabel Terry Lewis, Gladys Young, Gwendolen Evans, Jane Baxter, and Richard Coolden.

On Monday and Wednesday at 8 (Reg.) and 6.40 (Nat.) respectively will again be heard "Sweeny Todd," with Tod Slaughter in the name part.

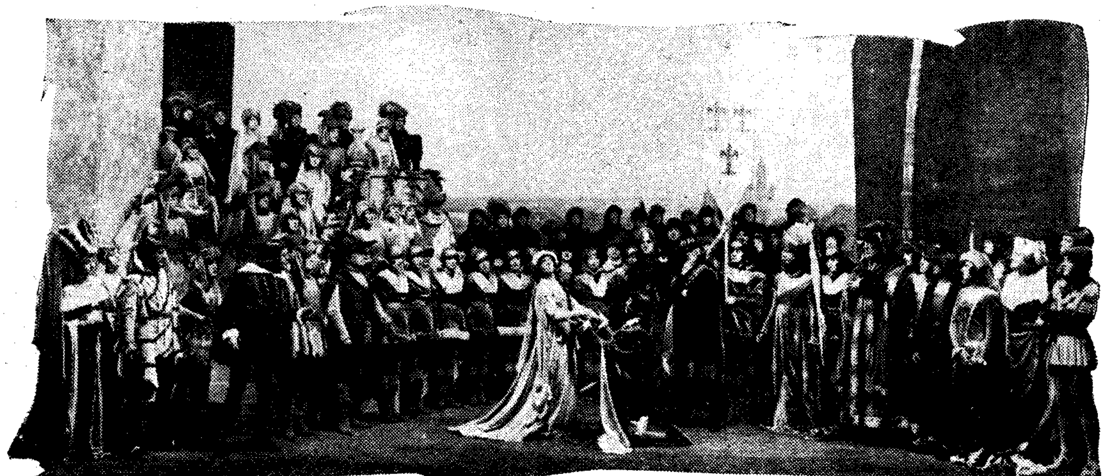
The third repetition is "Opium Eater," the radio-dramatic reconstruction by Paul Dehn and Felix Felton from the "Confessions" of de Quincey, and consists of three episodes, namely, Manchester Grammar School, Oxford Street, and Opium. This was last heard in October, 1935, and comes to Regional listeners on Tuesday at 8.

"FLYING HIGH"

BOTH the Army and Navy have been represented in special programmes, such as "The Roosters" and "Eight Bells," and now we are to hear an all-flying show. The scene is an aerodrome in France on a "dud" evening for flying. All those in the cast are one-time members of the Royal Flying Corps, the Royal Naval Air Service, or the Royal Air Force, and includes Hugh Wakefield, Laddie Cliff, Roy Royston, Ralph Coram, and G. H. Elliott. The major part of St. George's Hall will be filled with members of the Comrades of the Royal Air Force Association, and since most of the songs included will be of the 1917/1918 vintage, and, therefore, familiar to those sitting in the stalls, there should be nothing half-hearted in the chorus work. "Flying High" should be well worth listening to on Wednesday at 7.30 (Nat.).

"THE VAGABOND KING"

WHAT should prove an exceptionally attractive broadcast comes into the National programme on Thursday at 7.15, and is to be repeated Re-

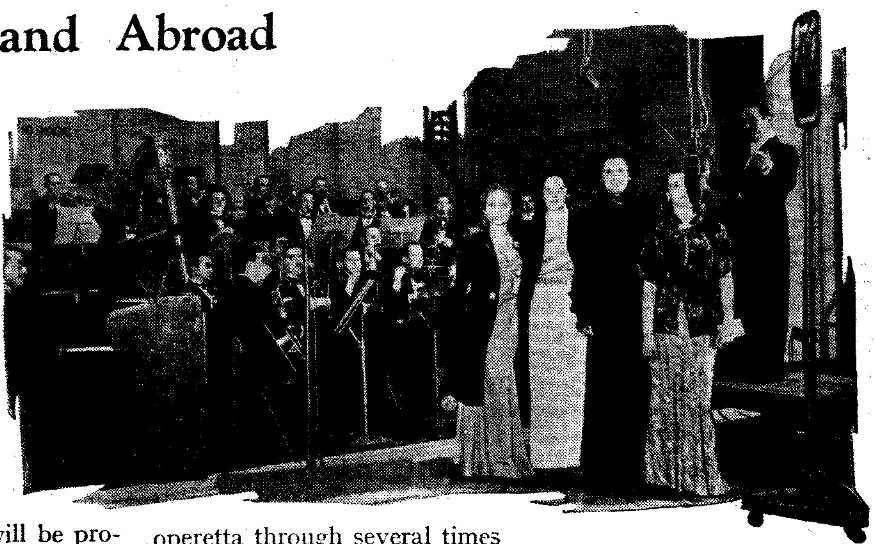


THE VAGABOND KING, a full stage scene from which, taken during the Winter Garden production in 1927, is here shown, will be broadcast on Thursday and Friday (November 27th).

de for the Week

asts at Home and Abroad

GERALDO and his "Romance in Rhythm" Orchestra seen with the Radio Three and Marjorie Stedeford which will be heard in the fourth "Music Shop" programme at 7.20 (Nat.) on Monday.



gionally on the following evening when "The Vagabond King" will be produced by John Watt. He has persuaded Bebe Daniels to take the lead, and has included in a very brilliant cast, Donald Mather, H. A. Saintsbury, Bobbie Comber, Gordon Little, and Sylvia Welling. To help him in the condensation, John Watt saw the operetta through several times at the recent Wolverhampton production. He says that he has left in the radio adaptation all the best music.

ROADMAKER

It is one hundred years on Thursday, November 26th, since the death of John Loudon McAdam, the inventor of the method of road construction which bears his name. On this day, at 9.20, in the National programme, a talk, "The Colossus of Roads," will be given by Mrs. Roy Devereux, his great great-granddaughter.

NEW SERIAL

The Saturday night serial story, "Sanders of the River," closed last week, and a new one starts to-morrow at the usual time, 8 (Nat.). It has been specially written for broadcasting by Maurice Moiseiwitsch, nephew of the famous pianist, and introduces a new character, Mr. Penny. Each week an adventure of this little man will be serialised. This week's episode will be "Mr. Penny on Government Service."

OPERA

Home: From the Royal Opera House, Covent Garden, on Tuesday from 9.45 to 10.20 and 10.40 to 11.25, will be heard Acts I and II of Moussorgsky's "The Fair of Sorotchinsk."

Abroad: The French National stations present an exceptional opera event on Saturday, at 8.45, in the form of a Charpentier evening. The first item, the *scène lyrique,* "Didon," is probably unknown to most English listeners, but the fourth act of "Louise," which comes later in the evening, is much more popular.

"Aïda" comes from Rome on the same evening at 8. This was first performed at the opening of the Cairo Opera House, for which event it had been commissioned by the Khedive of Egypt, the chief characters in the story being the King of Egypt and the King of Ethiopia. This will also be heard from Milan on Wednesday at 8.

Strasbourg is celebrating the 18th anniversary of the entry of the French troops into Strasbourg with a gala performance of Donizetti's "The Daughter of the Regiment" on Sunday at 8.30.

An interesting revival comes from Frankfurt and Stuttgart on Tuesday at 7.10, when one of Conradin Kreutzer's lesser-known operas, "Die Alpenhütte," will be given.

NEWS REEL

Listeners to Cologne on Monday at 7.10 will hear the station's own recordings of important events with the heading, "News Reel of Western Germany." Even those who are not familiar with German will find this interesting, as each shot is accompanied by music and effects.

OUT OF THE PAST

Popular tunes of days gone by, including Viennese and Parisian dances, "hits" from Copenhagen in the 'nineties, and Danish folk dances, will be revived in a programme from Kalundborg at 8.40 on Saturday.

N.B.C. photo.

ROBERT RIPLEY, some of whose "Believe It or Not" features will be included in another "Strange to Relate" programme on Monday at 8.30 (Nat.).

DANISH LIFE GUARDS

From Kalundborg on Sunday at 2.25 will be heard the band of the Royal Danish Life Guards in the season's Seventh Popular Sunday Concert. This military band is classed as one of the foremost in Scandinavia. The Auditor.

HIGHLIGHTS OF THE WEEK.

FRIDAY, NOVEMBER 20th.

Nat., 6.25, Violin Recital—Eda Kersey. 8.10, G.P.O. Feature Programme.

Reg., 6, B.B.C. Military Band and Parry Jones. 7.45, "The Canterbury Pilgrims" from Belfast.

Abroad.

Vienna 7.45, Vienna Symphony Orchestra — Guest conductor, Alfredo Casella.

SATURDAY, NOVEMBER 21st.

Nat., 5.15, Peter Yorke and his Orchestra. 7.30, "In Town To-night." ¶B.B.C. Theatre Orchestra, Tessa Deane and Webster Booth. 9.20, Music Hall.

Reg., 3, G.P.O. Feature Programme. 7.30, The Gershom Parkington Quintet. 8.15, "Laugh that Off"—American Humour.

Abroad.

Rome, 8, "Aïda," from the Teatro Comunale, Bologna.

SUNDAY, NOVEMBER 22nd.

Nat., 5.20, St. Cecilia Programme. 6.30, B.B.C. Theatre Orchestra—Victorian Melodies. 9.5, "The Importance of Being Earnest."

Reg., 5, The Luton Band. 5.40, "I Was There"—The Siege of Lucknow. 6.30 Sunday Orchestral Concert—conductor, Pau Casals. ¶The Worthing Municipal Orchestra.

Abroad.

Cologne, 7.30, "The Swan Song"—Last Works of Famous Composers.

MONDAY, NOVEMBER 23rd.

Nat., 7.20, "The Music Shop"—IV. 8.30, Strange to Relate. 9.35, Sonata Recital—Cassado ('cello) and Uhrer (piano).

Reg., 6, B.B.C. Military Band and Walter Widdop. 8, "Sweeny Todd."

Abroad.

Lyons, PTT, 8.30, "Véronique"—Operetta (Messager).

TUESDAY, NOVEMBER 24th.

Nat., 8, Van Phillips and his Two Orchestras. 8.30, Pianoforte Recital—Franz Osborn. 9.45 and 10.40, "The Fair of Sorotchinsk" from Covent Garden.

Reg., 6, Reginald King and his Orchestra. ¶Eugene Pini and his Tango Orchestra. 8, "Opium Eater." ¶B.B.C. Northern Orchestra and Tina Bonifacio (harp).

Abroad.

Paris, PTT, 8.30, Don Juan and Romeo and Juliet in the Works of Various Composers.—Concert from the Conservatoire.

WEDNESDAY, NOVEMBER 25th

Nat., 6.40, "Sweeny Todd." 7.30, "Flying High." 8.15, and 9.50, Symphony Concert from the Queen's Hall.

Reg., 8.15, Soft Lights and Sweet Music. 9.15, B.B.C. Theatre Orchestra.

Abroad.

Hamburg, 8, Concert by the Goslar Huntsmen.

THURSDAY, NOVEMBER 26th.

Nat., 7.15, "The Vagabond King." 9.20, "The Colossus of Roads"—Mrs. Roy Devereux. 9.40, Tower Bridge Programme.

Reg., 6.40, From the London Theatre. ¶The Halifax Choral Society's Concert from the Victoria Hall, Halifax.

Abroad.

Cologne, 8, "The Willis," Puccini's First Opera.

Special-Purpose Rectifiers

HEAVY-DUTY AND HIGH-VOLTAGE TYPES AND THEIR APPLICATIONS

AFTER outlining the technique of power rectification as employed in normal broadcast sets, the author goes on to describe special rectifiers and circuits for high-power receivers, amplifiers, television sets, etc.

By A. L. M. SOWERBY, M.Sc.

THE usual mains-driven set consumes, all told, an anode current of the order of 60 to 80 mA. at about 350 volts. This voltage is higher than is required for the receiver itself, but the excess voltage is lost across the field winding of the speaker, which is normally placed in series with the anode current supply to all valves. A little more voltage is lost in providing bias for the valves.

The rectifier normally chosen for this duty is a full-wave rectifier which will deliver 120 mA. at 350 to 360 volts, being rated for 350-0-350 volts RMS on its anodes. Such a valve, a few years ago, would quite certainly have been classed as a "heavy-duty" rectifier; at the present time one would rather regard it as the biggest of the "normal-duty" valves, and look upon the heavy-duty class as beginning with valves capable of delivering anode current at some 500 volts.

In accordance with a scheme of partial standardisation introduced some years ago, all valve-makers now offer a full-wave rectifier rated at an AC anode voltage of 500-0-500, and capable of delivering a continuous current of 120 milliamps. This is sufficient to run a single output valve of the 400-volt 63 milliamp class, and of providing at the same time both the necessary excess voltage for energising a loud-speaker field and the current required for the rest of the receiver. An output stage of this type will deliver some 5 to 6 watts to the loud speaker. This is a very generous output for ordinary domestic use, and is adequate for a public-address system to be used in a small hall.

Two output valves of this class, if over-biased a trifle and run in push-pull will give more than double this output; a rectifier of the type mentioned will just provide the necessary current for the output stage and the loud-speaker field, but will have no spare milliamps. for the rest of the receiver. In such a case an auxiliary HT supply, providing perhaps 50 mA. at 250 volts, is generally used for earlier valves; this is preferable to duplicating the high-voltage rectifier, as it separates the output stage from the rest of the equipment and does away with the need for voltage-dropping resistances and high-voltage condensers in the early part of the set.

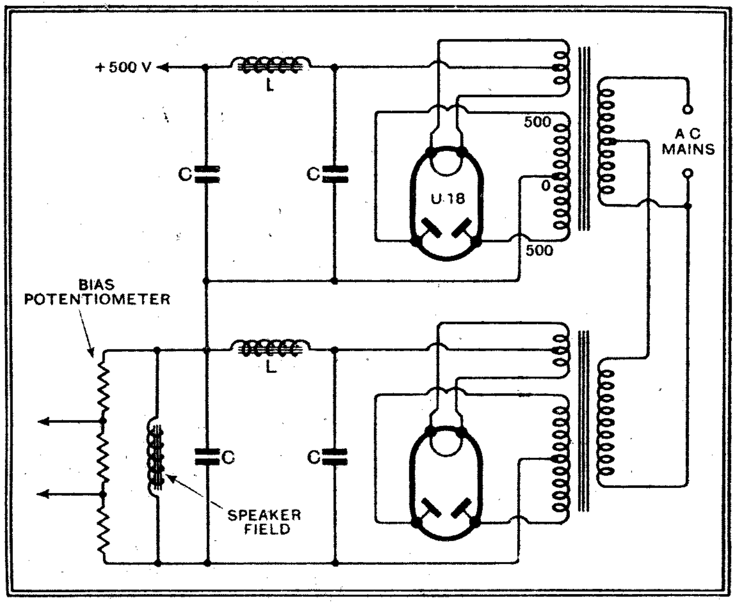


Fig. 2.—Circuit showing high-voltage rectifier for anode current, with auxiliary low-voltage rectifier (about 150 volts) supplying field of speaker and also grid bias.

It must not be forgotten in considering these rectifiers, that the maker's rating concerns the RMS value of the alternating voltage applied to the anode. The actual DC voltage developed, even at full load, is appreciably in excess of the AC rating. This is shown in Fig. 1, which gives the regulation curve of the Mazda UU120/500; with a reservoir condenser of 4 mfds. the output is about 575 volts at 120 milliamps, rising a little at lower currents. The Cossor 460 BU, the Marconi or Osram W14, and the Mullard DW4 are similar.

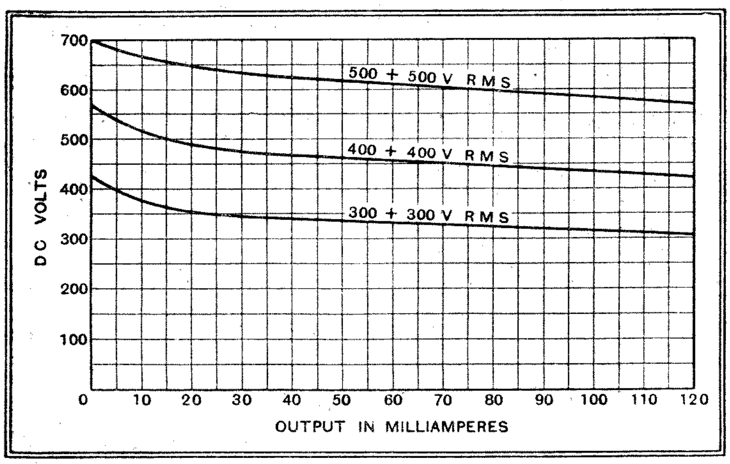


Fig. 1.—Regulation curves of Mazda UU120/500 rectifier with 4-mfd. reservoir condenser. Note that DC output voltage, even at full load, exceeds RMS value of AC applied.

Besides these directly heated valves, indirectly heated rectifiers are obtainable in the same rating. These are a newer introduction, and are very suitable for use in cases where some or all of the valves in the set are also indirectly heated, since the anode voltage is not applied until all the valves are drawing current. The Marconi or Osram MU14, the Mullard IW4, the Hivac UU120/500, and the Standard R3 belong to this category.

For still larger outputs, running up to 250 milliamps at 500 volts, a rectifier such as the Marconi or Osram U18 will probably be chosen. This will run a push-pull pair of 400-volt 63-milliamp valves, and still have plenty of reserve for the rest of the set. Alternatively, it would drive an output stage consisting of four such valves in parallel push-pull, from which the very respectable output of some 25 watts may be expected in normal circumstances.

If it is not called upon to energise the speaker, which normally involves the loss of about 100 volts, it will satisfactorily provide anode current (but not grid-bias) for a pair of DA30 type valves used as a low-load push-pull pair, or even to a pair of DA60 valves as ordinary Class A amplifiers in push-pull or parallel. These valves take 120 milliamps each at 500 volts. In either of the last two arrangements, it is suggested that the speaker-field can profitably be excited from a small separate rectifier, this also supplying the rather high grid-bias (round about 130 volts), which these large output valves require. A circuit of this type is shown in Fig. 2.

Special-Purpose Rectifiers—

In setting up a circuit of this kind care should be taken that the reservoir condenser is not too large, or the valve, if called upon to deliver a steady current of the maximum value for which it is rated, may pass a dangerously high peak current. It is also important that the smoothing chokes should be adequate for the very large current they are called upon to carry. This means a large core, gapped to prevent magnetic saturation. Since, in addition the resistance has to be fairly low to prevent undue loss of volts (one volt for every four ohms) at the high current the choke has to pass, the winding must be of comparatively few turns of thick wire. This, like the gap, necessitates an increase in the total size of the core. Those who have never met a smoothing choke of 20 henrys designed to carry 250 milliamps at a voltage drop not exceeding 25 volts will be taken aback at its bulk and weight—and probably at its price, too.

For PA or Cinema Work

It is not very often that one requires higher voltages and currents than those given by the valves just described, which are the biggest of the thermionic rectifiers of ordinary type. But for large public-address systems, or cinema work, it may be desirable to run an output stage consisting of one or possibly two valves such as the Marconi or Osram DA100 or the Mazda ES100. These, as their name implies, are output triodes of 100 watts dissipation; they take their power in the form of an anode current of 100 mA. at 1,000 volts, and require a bias of nearly 150 volts.

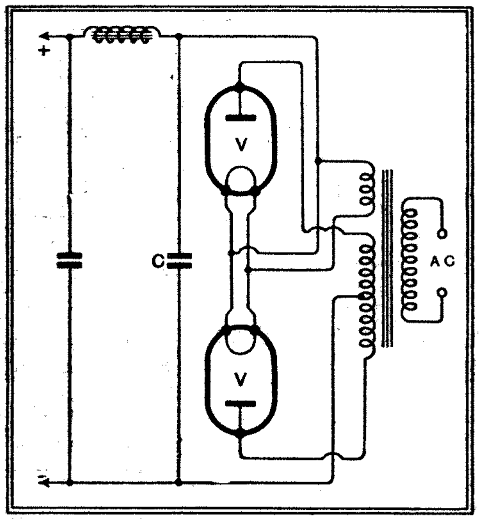


Fig. 3.—Standard type of smoothing circuit. Not suitable for mercury-vapour rectifiers, owing to possibility of surges of current into the reservoir condenser C.

For such power consumption as this the thermionic rectifier is best deserted for one of the mercury-vapour valves such as the Marconi or Osram GU1 or GU5, or the Ediswan MU1 or MU2. These valves have a very heavy filament, consuming 3 amperes at 4 volts, and differ from an ordinary rectifier in being "filled" with mercury vapour instead of being completely evacuated. When the voltage applied to the anode exceeds the ionisation voltage of mercury—about 13 volts—the electrons from the cathode ionise some of the mercury atoms in the bulb. The positive ions so produced neutralise the space-charge round the cathode and allow all the emitted electrons to reach the anode, so far as the external resistance of the circuit permits.

This implies that the internal resistance of a mercury-vapour rectifier, once the discharge starts, is extremely small. The total energy dissipated in the bulb, and therefore the heat developed, is in consequence very little more than the filament wattage; a small bulb can therefore be used for a rectifier dealing with considerable power.

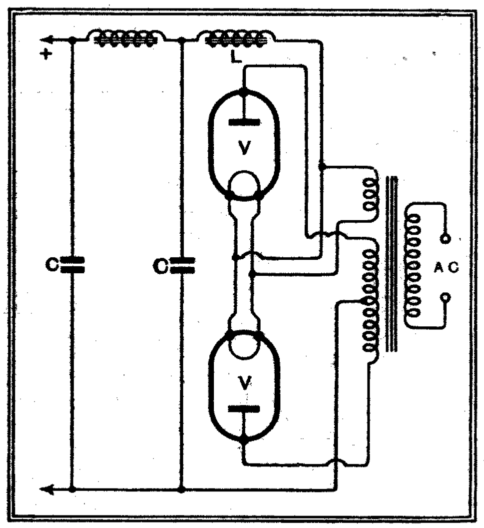


Fig. 4.—Smoothing circuit with input choke L. With mercury-vapour rectifiers at V, this circuit prevents sudden surges.

With so low an internal resistance it is evident that if at any time the load-resistance is removed (HT positive shorted to earth, etc.) outrageously high currents will immediately flow. If the current rises so far that the emission of the valve, and not the circuit resistance, is the sole limit to the current, mercury ions will bombard the cathode with such energy as to cause the destruction of the emitting coating within a few minutes. It is therefore desirable to include either a fuse or a limiting resistance in series with the anode circuit of the rectifying valve.

If the ordinary smoothing circuit of Fig. 3 is used, there is nothing to limit the flow of current into the reservoir condenser. To switch the HT on to the anodes with the reservoir condenser discharged would result in a current of several amperes—perhaps several hundred amperes—for a fraction of a second. These sudden surges can be satisfactorily prevented by using a filter with a choke input, as suggested in Fig. 4. The makers recommend that when using GU1 valves L should not be less than one henry, while with the higher voltages applied to the GU5 valves the value of L should not fall below some 9 henrys.

Besides a rise in current, there is another way in which the current flowing can equal the full emission from the cathode; that is by a fall in emission. If this occurs at the end of the valve's life, no harm is done—the valve is dying, anyway, and one does not mind delivering the *coup de grâce*. But if the emission falls through inadequate filament current the cathode bombardment will again occur, and will probably destroy, and certainly damage, the valve. Full filament voltage must therefore be carefully maintained.

For just the same reason the anode voltage must not be applied until the cathode has had full time to warm up. Either the user must switch on the filaments, wait for a minute or two, and then switch on the HT, or he must fit a thermal-delay switch to perform the delayed switching automatically. Such switches are obtainable from several makers; the vacuum - enclosed Ediswan switches (DLS/1 and DLS/10) are particularly attractive. Like other delayed-action switches, they depend on a bi-metallic strip built up from two metals which expand unequally on the passage of current through a heater.

The only exception for the need for delayed switching is when the current to be taken from the rectifiers is small: in the case of the Marconi and Osram GU1 and GU5 valves it is permissible to switch filament and anode voltage simultaneously provided that the total current to be drawn does not exceed 60 milliamps per valve, though with delayed switching each is capable of delivering up to 250 milliamps at voltages up to 1,180 in the case of the GU1, rated at 1,000 volts RMS, and 1,260 volts in the case of the GU5, rated for 1,500 volts RMS. The lower figure in the latter case is due to the need for using a choke of higher inductance at L (Fig. 4).

Advantages of Mercury Rectifiers

A pair of GU5 valves, delivering up to 500 milliamps at 1,280 volts, will comfortably provide anode current and bias for four DA100 valves in parallel-push-pull, giving an undistorted output that is probably not far short of 150 watts. This will drive ten to twenty speakers of the ordinary 12-inch type at not far short of the maximum power they can handle without discomfort.

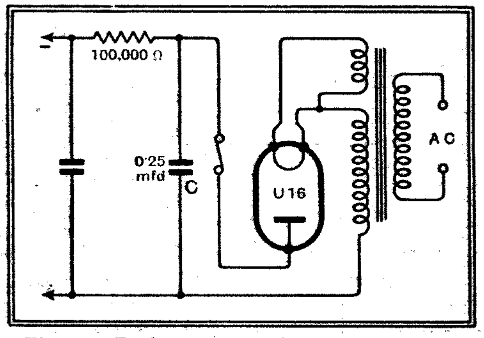


Fig. 5.—Resistance-capacity smoothing for low-current high-voltage unit suitable for cathode-ray tubes.

Special-Purpose Rectifiers—

These mercury rectifiers, owing to their very low internal resistance, are very desirable for use whenever the load is likely to fluctuate rapidly. For any form of Class "B" or quiescent or semi-quiescent push-pull output stage, a power unit including mercury-vapour rectifiers is almost essential if the rapidly changing current demands are not to cause corresponding changes in anode voltage. It need hardly be pointed out that in such a connection the resistance of the smoothing chokes must be kept as low as possible, as must the resistance of the mains transformer windings.

For operating a cathode-ray tube high voltages are necessary, but the current taken is quite small. For this purpose the thermionic rectifier, suitably designed, is very well fitted. The Marconi or Osram U16 and U17, the Cossor SU2130, and the Mullard HVR1 are all of this type. Essentially they are half-wave rectifiers of quite ordinary type but having their single plate brought out to the top cap of the bulb for the sake of providing adequate insulation against the very high voltages used. The HVR1 will take up to 6,000 volts RMS, and is rated to deliver up to 5 milliamps continuously. The U16 is a similar valve, rated for 5,000 volts RMS, and handling currents up to 2 milliamps. Where larger currents are needed the U17, taking 2,500 volts RMS and yielding up to 30 milliamps, is more suitable.

In all these cases it is usual, since the current is comparatively small, to use resistance-capacity smoothing in a circuit such as that of Fig. 5. The voltages and currents available from the U16 and U17 valves are shown in Fig. 6, and give a good idea of the outputs that can be had from valves of this class.

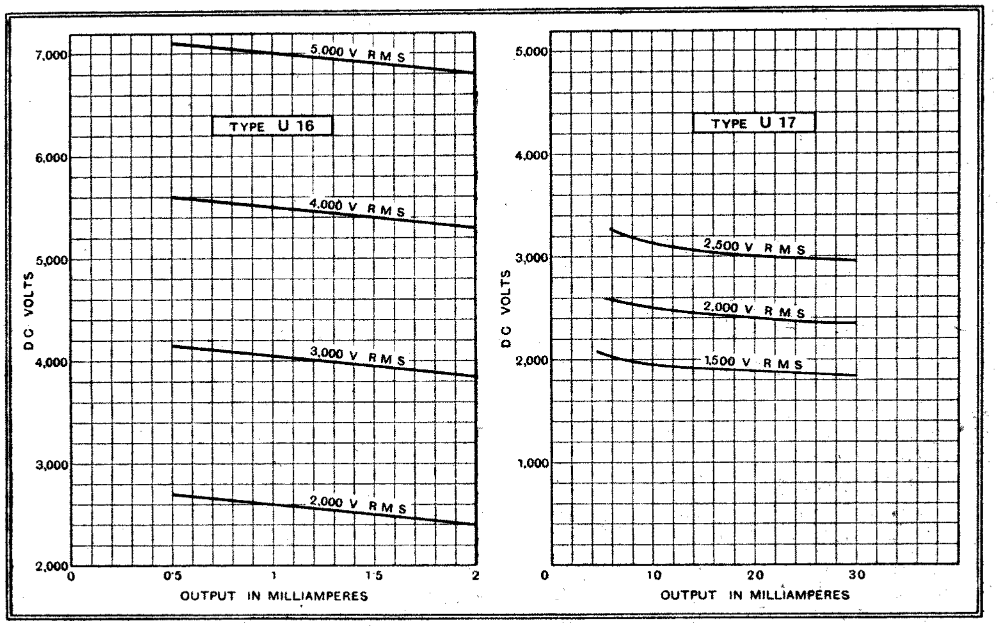


Fig. 6.—Regulation curves of U16 and U17 rectifiers. Note that in the case of the U16, but not the U17, the voltage-drop in the smoothing circuit of Fig. 5 is taken into consideration.

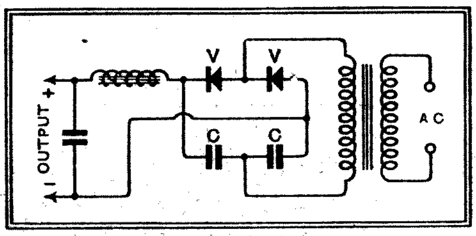


Fig. 7.—Voltage-doubling circuit for high voltages from metal rectifiers: C, C are the two "voltage-doubling" condensers, each of which acts as reservoir condenser for one rectifier.

Mazda produces a mercury-vapour rectifier, the MU2, for similar work. This may have applied to it up to 4,000 volts RMS, and will give up to 5 milliamps continuous. For this low-current use delayed switching is not required, though if this precaution be taken the valve can be turned to other uses and employed to deliver a higher current at a lower voltage.

Besides the vacuum and the mercury-filled valves, a metal rectifier may be used for cathode-ray work. These are available from the Westinghouse Company in two forms, known by the letters J and H. The former rectifiers give a maximum output of 2 milliamps, and may be used as simple half-wave rectifiers for output voltages up to 1,400 volts. Still higher outputs, up to 3,000 volts, may be had by arranging them in pairs in the voltage-doubling circuit of Fig. 7, while the same circuit using five 1,400-volt rectifiers in series on each side will enable outputs up to 15,000 volts, still at 2 milliamps, to be obtained. It is necessary to use one rectifier on each side for every 3,000 volts required.

The voltage-doubling or reservoir condensers do not need to be large, for the current drawn is small; for single-wave rectification at 1,400 volts 0.5 mfd. is recommended by the makers, this condenser being doubled or halved if the output voltage is halved or doubled. For voltage-doubling *each* of the two condensers has this value.

The H-type rectifier is rated at a continuous output of 10 milliamps; the largest of them gives up to 650 volts in the half-wave or 1,300 volts in the voltage-doubler circuit. The reservoir condensers recommended are 0.5 mfd. for 650 volts half-wave, or 0.25 mfd. each for the 1,300 volts. As with the J-type, higher voltages can be obtained by putting two or more rectifiers in series, reducing the capacity of the reservoir condenser accordingly.

Both these rectifiers have the outward form of a long thin rod with a terminal at each end; in either series the largest is $\frac{7}{16}$in. in diameter and 13 inches long.

The Radio Industry

THE Raymart Manual, a well-prepared booklet issued by Raymart Manufacturing Co., 44, Holloway Head, Birmingham, 1, has just been published; price 6d. (by post 7½d.). It contains much useful information for amateurs, particularly with regard to short-wave work, and also includes a number of transmitting circuits. The specialised Raymart apparatus is also described in its pages.

Speech reinforcing equipment and radio loud speakers have been installed in the new building of the Royal Empire Society by Voigt Patents, Ltd. Seven Voigt loud speakers, each with horns suited to the particular purpose and space available, form a permanent part of the building, as the installation was made at an early stage with the collaboration of the architects.

The new H.M.V. catalogue of gramophone records runs to nearly 500 pages and contains particulars of over 6,000 records covering every kind of music and also speech. Records by members of the Royal Family now occupy a whole page and many historical speeches have been recorded. Although we cannot hear what Gladstone said in 1872, there is no mistake as to what Mr. Lloyd George said in 1909!

The October issue of the Bulgin Monthly Bulletin contains constructional details of a three-valve all-wave battery set, as well as much useful information about the latest Bulgin products.

WHERE THE PUBLIC CAN SEE TELEVISION DEMONSTRATIONS

Place.	Particulars.
Science Museum, South Kensington.	Free.
Waterloo Station	Free to railway ticket holders (Southern).
Army & Navy Stores, Ltd., 105, Victoria St., S.W.1.	Free.
Bentalls, Kington-on-Thames ...	Demonstrations shortly.
Bon Marché, Ltd., Brixton Rd., S.W.9.	From Nov. 9th for two weeks, in the Restaurant.
John Barker & Co., Ltd., High St., Kensington, W.8.	Demonstrations shortly.
A. W. Gamage, Ltd., Holborn, E.C.1.	Free.
General Electric Co., Magnet House, Kingsway, W.C.2.	Free.
Harrods Ltd., Brompton Rd., S.W.1.	Free.
A. Imhof, Ltd., 112, New Oxford St., W.C.1.	Free.
Gramophone Co., Ltd., 98-108, Clerkenwell Rd., E.C.1.	By arrangement with their local H.M.V. dealer, readers of THE WIRELESS WORLD can have free demonstrations.
Hendon Motor Co., 48, Vivian Ave., Hendon Central, N.W.4 (not far from Hendon Central Underground).	Demonstrations daily from 3–4 p.m., and by appointment only from 9–10 p.m.
Murdoch, Murdoch & Co., 463, Oxford St., W.1.	Free, by invitation.
E. Rogers & Sons, Ltd., 56, 58 & 64, High St., Weybridge.	Free.
Royal Arsenal Co-operative Society, Ltd., various branches in S. London.	Free.
Selfridge & Co., Ltd., Oxford St., W.1.	Free. Appointments have to be booked.
Thomas Wallis & Co., Ltd., Holborn Circus, E.C.1.	Free.
Wm. Whiteley, Queen's Rd., Bayswater, W.2.	Free.

The Wireless World VALVE DATA SUPPLEMENT

Facts and Figures on the 1936–1937 Types

THE number of valves increases steadily each year and the amount of information required about each specimen increases also, for the ever widening variety of uses to which they are put demands a greater knowledge of the characteristics of each type. Each year, therefore, *The Wireless World* Valve Data Supplement, which presents in compact form detailed information on all current specimens, grows in size. This year more complete data on valve characteristics is given, and in addition American types are included, while valve base connections for both British and American valves are also to be found.

Owing to the enormous number of valves now made it has been found necessary to omit those of the older types which must be considered obsolete. The guiding principle here has been to omit 4-volt and 6-volt battery valves and those specimens for which a newer equivalent exists.

The data is divided into sections for the types of radically different construction or use, and in each section the valves are arranged in order of filament or heater voltage. A few years ago, with but few exceptions, valves had either 2-volt or 4-volt filaments. Now there is a surprising variety. Battery types are still rated at 2 volts, naturally enough, since most people use an accumulator, and a single cell only is convenient. The indirectly heated types, however, require 4, 6.3, 13, 20, 25, 30, 35, and 40 volts. The extension of voltages has been brought about by the car set and the AC/DC receiver. In the latter all valves must consume the same current, for they are connected in series; the voltages of the heaters consequently vary in the different types just as the currents taken by the heaters vary in constant voltage valves. The 13-volt range, which overlaps greatly with the AC/DC range, has been brought into being for car radio, and the valves are intended for operation from the usual 12-volt accumulator. The 6.3 volt range has also been developed for the same purpose, but for cars which have only a 6-volt accumulator. In America, few, if any, cars have a 12-volt battery, and so the valves are of the 6.3 volt type. Although originally developed for car radio and AC/DC sets, they are now almost universally employed in AC receivers, and the older 2.5 types, although still widely used, have been superseded in the newer receivers.

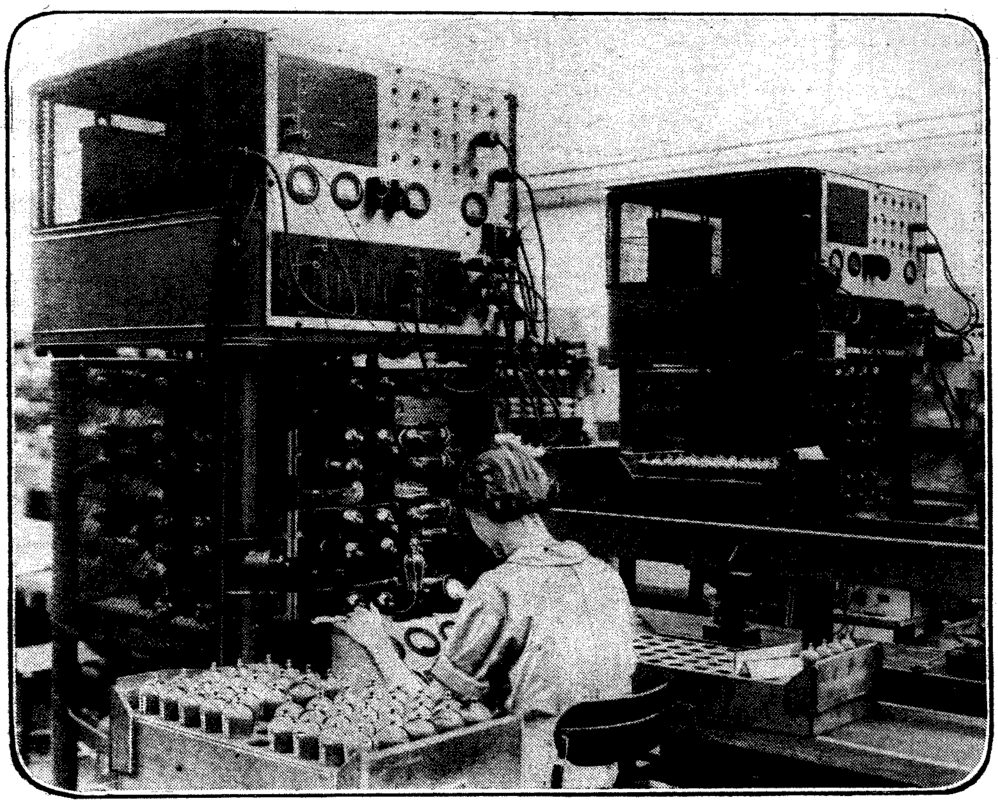
Frequency-changers

Among the sections into which the valves are divided, the first is headed Frequency-Changers. In this fall those valves which have been developed to perform this essential function to the superheterodyne. There are four types:— the heptode, the octode, the triode-pentode, and the triode-hexode; among the American valves is one which is a type in itself, of which more anon. The valves perform two functions and consist really of two more or less independent sections. Each contains in essentials a triode oscillator and a multi-electrode mixer.

In the case of the heptode, the cathode is surrounded by two grids which form the grid and anode of a conventional triode oscillator. This assembly is surrounded by a screen-grid, and then comes the control-grid of a screen-grid type valve, followed by another screen grid and an anode. This type of valve is thus analogous to a triode oscillator and a screen-grid valve in series. The octode is similar, but has a suppressor grid between the outer screen-grid and the anode, and is analogous to a triode and an RF pentode in series.

The triode-pentode is quite different, for the two electrode assemblies are entirely distinct save that they operate on a common cathode. No internal interconnection exists and the valve is exactly equivalent to the two-valve frequency-changer built up of an RF pentode mixer and a triode oscillator. External coupling between the two sections must be provided.

The triode-hexode is, relatively speaking, a newcomer. It contains two separate electrode assemblies with a common cathode. One is a triode and functions as an oscillator, while the other is a hexode which serves as a mixing valve. In the construction the cathode is surrounded by the control grid, and this in turn by two concentric screen-grids between which is the injector grid which is internally con-



Two special machines in the valve-making department of the Ferranti Co's. radio works that are used for the standard routine testing of valve characteristics.

"Wireless World" Valve Data Supplement— nected to the grid of the triode assembly. The anode comes outside the outer screen grid.

Apart from the ordinary frequency-changers, one unusual valve will be found among the American types. This is the 6L7; it contains only the electrodes of a mixing valve and requires a separate oscillator. The electrode arrangement is similar to that of a hexode, but there is an extra grid between the outer screen-grid and the anode which functions as a suppressor-grid.

In general characteristics the heptode and octode are very similar, but the latter generally has a higher AC resistance and so damps the first IF tuned circuit to a lower degree. The triode-pentode also has a high AC resistance and generally a high conversion conductance, but has the disadvantage of requiring external oscillator coupling. The triode-hexode has a high AC resistance and a conversion conductance comparable with that of other types; internal coupling is obtained by electronic means and the mutual conductance of the oscillator section of the valve is higher than is generally found with heptodes and octodes. Consequently, it oscillates more readily and can be used at shorter wavelengths. There is also greater freedom from interaction between the signal- and oscillator-frequency circuits with this valve, and this is particularly valuable in short- and ultra-short-wave reception.

Screen-grid Valves

The ordinary screen-grid tetrodes and pentodes are now rarely used for RF and IF amplification, having been superseded by the variable-mu types. There are signs, however, of a revival of interest in this class for television purposes. Several makers have recently produced pentodes with very high values of mutual conductance in order to permit reasonable stage gain with the enormous band-width required in a television amplifier. The tetrodes also find application as dynatron oscillators and in the separation of the synchronising impulses in television receivers. This class thus cannot be considered as even approaching obsolescence.

When used as an amplifier the stage gain can readily be calculated by multiplying the mutual conductance of the valve (mA/V) by the parallel value of the dynamic resistance of the tuned circuit and the valve's own AC resistance and dividing by 1,000. When the valve resistance is very high compared with the dynamic resistance, the gain is nearly equal to the product of mutual conductance and dynamic resistance divided by 1,000. Expressed algebraically,

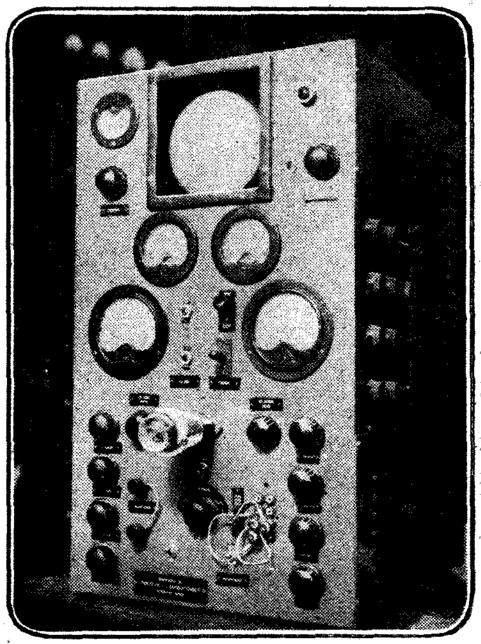
$$\text{Gain} = \frac{g\,R_a\,R_D}{R_a + R_D} \approx g\,R_D \text{ when } R_a \gg R_D.$$

This same equation is accurate also for other valves. In the case of frequency-changers, conversion conductance must be substituted for mutual conductance, and with resistance-coupled amplifiers R_D becomes the value of the coupling resistance in parallel with the grid leak of the following valve. The equation is exact for all classes of amplifiers in which resistance or a resonant tuned-circuit coupling is used. It does not apply when the coupling is largely reactive.

In the past, it has been customary to use the simplified equation (for $R_a \gg R_D$) for all calculations with tetrodes and pentodes and to retain the exact expression only for triodes. This is not always justifiable, however, for recent advances in coil design have made possible high values of dynamic resistance, and the simpler equation may lead one seriously astray when dealing with tetrodes and frequency-changers, although it is still reasonably accurate in most cases with pentodes, on account of their higher resistance.

Variable-mu Valves

In broadcast receivers the variable-mu valve is now almost universally employed for RF and IF amplification. The stage gain is calculated in the same way as with screen-grid valves of the sharp cut-off type. The difference between the ordinary screen-grid and the variable-mu valve, in fact, is merely that with the former the mutual conductance tends to remain constant as the grid bias is increased and then rapidly falls to zero, whereas with the variable-mu valve the mutual conductance falls continuously and gradually as the bias is applied. In practice, of course, the mutual conductance with both types falls on increasing the bias, but the change is much more gradual and a much higher bias voltage is needed to obtain the same minimum value with the variable-mu valve.



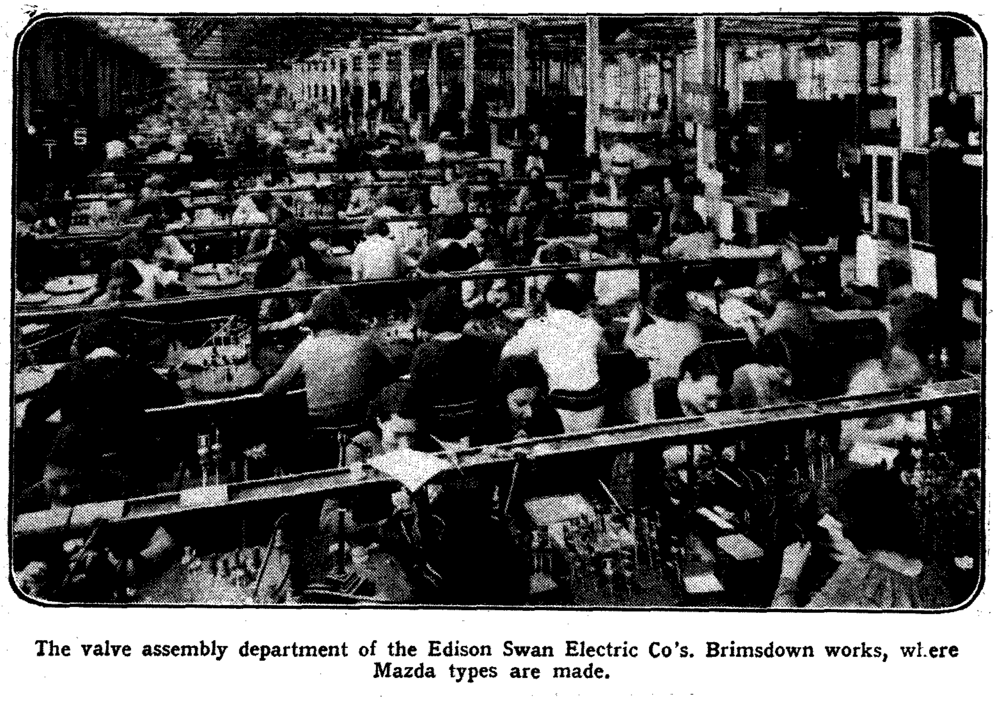
Cathode-ray tube and its associated apparatus used by the High Vacuum Valve Co. for the visual examination of the characteristic curves of Hivac valves under working conditions.

The practical result is that it is possible to control the amplification within wide limits by varying the grid bias of variable-mu valves without distortion or cross modulation being introduced. This statement must be taken conservatively, of course, for there is naturally a limit to the conditions under which freedom from distortion occurs, and even with variable-mu types trouble will be experienced if the input exceeds a certain figure.

With all valves the inter-electrode capacities are important, but they are especially so in the case of types which are used for RF and IF amplifiers. The input and output capacities usually occur in parallel with the tuned circuits and are only important in that they increase the minimum capacity of these circuits and so restrict the tuning range. The effect is most noticeable in short-wave reception, but it must be remembered that a receiver will require retrimming if a valve is replaced by one having different capacities.

The grid-anode capacity, however, is important in that it very greatly affects the stability; it does, in fact, place a definite limit to the possible stable gain even with

(*Continued on page 554.*)



The valve assembly department of the Edison Swan Electric Co's. Brimsdown works, where Mazda types are made.

FREQUENCY-CHANGERS

Type.			Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Screen.	Volts. Grid.	Current (mA.). Anode.	Current (mA.). Screen.	AC Resistance (MΩ).	Conversion Conductance (mA/V.).	Opt. Osc. Volts (Peak).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
BRIMAR ..	15 A 2 (H)	.. tet.	4.0	0.65	250	100	− 3.0	3.5	2.0	0.3	0.6	10.0	8.0	9.0	0.2	7 B	15/-
	,,	.. osc.			200	—	—	—	—	—	0.75	—	—	—	—		
	15 D 1 (H)	.. tet.	13.0	0.2	250	100	− 3.0	3.5	2.0	0.3	0.6	10.0	8.0	9.0	0.2	7 B	15/-
	,,	.. osc.			200	—	—	—	—	—	0.75	—	—	—	—		
CLARION ..	FC 4 ..	.. —	4.0	1.0	250	70	− 1.0	1.8	4.0	1.5	0.6	12.0	—	—	—	7 B	6/6
	FC 13 ..	.. —	13.0	0.2	200	70	− 1.0	1.8	4.0	1.5	0.6	12.0	—	—	—	7 B	6/6
COSSOR ..	210 PG (H)	.. tet.	2.0*	0.1	150	55	0	—	—	—	0.45	7.0	—	—	—	7 A	14/-
	,,	.. osc.			150	—	—	—	—	—	—	—	—	—	—		
	210 SPG (H)	.. tet.	2.0*	0.1	150	80	0	—	—	—	—	—	—	—	—	7 A	14/-
	,, ,,	.. osc.			150	—	—	—	—	—	—	—	—	—	—		
	41 MPG (H)	.. tet.	4.0	1.0	250	80	− 1.5	1.0	3.0	—	1.5	8.5	—	—	—	7 B	15/-
	,,	.. osc.			100	—	—	6.0	—	—	—	—	—	—	—		
	41 STH (TH)	.. hex.	4.0	1.15	250	100	− 1.5	3.0	4.0	—	0.7	12.0	—	—	—	7 B	15/-
	,, ,,	.. osc.			100	—	—	2.0	—	—	—	—	—	—	—		
	13 PGA (H)	.. tet.	13.0	0.2	250	65	− 1.5	1.0	3.0	—	0.75	8.5	—	—	—	7 B	15/-
	,,	.. osc.			200	—	—	6.0	—	—	—	—	—	—	—		
	202 MPG (H)	.. tet.	20.0	0.2	200	100	− 1.5	—	—	—	1.0	8.5	—	—	—	7 B	15/-
	,,	.. osc.			100	—	—	—	—	—	—	—	—	—	—		
DARIO ..	BK 22 (O)	.. pent.	2.0*	0.14	135	45	0	0.6	2.5	2.5	0.25	11.3	9.1	14.3	0.07	7 A	12/6
	TK 24 (O)	.. pent.	4.0	0.65	250	70	− 1.5	1.3	3.0	1.5	0.6	11.3	9.0	12.5	0.08	7 B	14/-
	TBC 5013 (O)	.. pent.	13.0	0.2	200	70	− 1.5	0.8	3.0	1.5	0.6	11.3	9.0	12.5	0.06	7 B	14/-
EVER-READY	K 80 A (O)	.. pent.	2.0*	0.125	150	70	0	0.8	0.75	—	0.2	13.0	9.9	14.5	0.057	7 A	14/-
	,,	.. osc.			150	—	—	—	—	—	—	—	7.0	6.4	—		
	A 80 A (O)	.. pent.	4.0	0.65	250	70	− 1.5	1.6	3.8	1.6	0.6	12.0	9.0	12.5	0.034	7 B	15/-
	,,	.. osc.			90	—	—	2.0	—	—	—	—	9.4	6.1	—		
	C 80 B (O)	.. pent.	13.0	0.2	200	70	− 1.5	1.6	3.8	1.6	0.6	12.0	9.0	12.5	0.034	7 B	15/-
	,,	.. osc.			90	—	—	2.0	—	—	—	—	9.4	6.1	—		
FERRANTI ..	VHT 2 A (H)	.. tet.	2.0*	0.1	150	70	− 1.5	1.2	2.1	0.75	0.3	10.0	11.5	7.0	0.3	7 A	14/-
	,,	.. osc.			70	—	—	0.45	—	—	—	—	6.0	5.0	4.0		
	VHT 4 (H)	.. tet.	4.0	1.0	250	100	− 3.0	2.6	5.1	0.5	0.7	15.0	15.0	16.0	0.3	7 B	15/-
	,,	.. osc.			100	—	—	1.2	—	—	—	—	11.0	9.0	5.0		
	VHTS (H)	.. tet.	13.0	0.3	250	100	− 3.0	2.6	5.1	0.5	0.7	15.0	15.0	16.0	0.3	7 B	15/-
	,,	.. osc.			100	—	—	1.2	—	—	—	—	11.0	9.0	5.0		
	VHTA (H)	.. tet.	13.0	0.2	250	100	− 1.5	3.2	5.6	0.5	0.7	15.0	15.0	16.0	0.3	7 B	15/-
	,,	.. osc.			100	—	—	1.3	—	—	—	—	10.0	8.0	5.0		
HIVAC ..	TP 230 (TP)	.. pent.	2.0*	0.3	150	70	0	4.3	0.8	—	0.325	3.5	9.1	9.7	0.004	9 A	14/-
	,,	.. osc.			60	—	—	0.9	—	0.026	—	—	1.3	1.8	3.2		

REFERENCES.

*	Directly heated filament.	(TD)	Triple-diode.
HW	Half-wave.	(P)	RF Pentode.
FW	Full-wave.	(H)	Heptode.
VD	Voltage-doubler.	(O)	Octode.
MV	Mercury Vapour.	(TP)	Triode-Pentode.
(B)	Class "B" valve.	(TH)	Triode-Hexode.
(Q)	QPP valve.	**	The mains transformer secondary should be tapped for these rectifiers, as with some specimens a lower voltage is needed to obtain the rated output.
(D)	Driver valve.	***	Also available with bayonet type base.
(T)	Tetrode.	††	Special double-triode.
†	Per pair in push-pull.		
‡	Under operating conditions quoted.		
(SD)	Single-diode.		
(DD)	Duo-diode.		

FREQUENCY-CHANGERS—(Continued)

Type.			Heater.		Volts.			Current (mA.).		AC Resistance (MΩ).	Conversion Conductance (mA/V.).	Opt. Osc. Volts (Peak).	Capacities (mmfds.).			Base.	Price.
			Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.				Input.	Output.	Grid-Anode.		
MARCONI and OSRAM.	X 21 (H) ..	.. tet.	2.0*	0.1	150	50	0	0.45	0.6	1.5	0.24	10.0	11.8	19.2	0.55	7 A	14/-
	,, ..	.. osc.			50	—	—	0.6	—	—	—	—	7.36	6.85	1.8		
	MX 40 (H)	.. tet.	4.0	1.0	250	80	− 3.0	2.75	2.0	0.5	0.5	10.0	14.0	16.0	0.1	7 B	15/-
	,,	.. osc.			150	—	—	2.1	—	—	—	—	7.0	4.0	2.0		
	X 42 (H) ..	.. tet.	4.0	0.6	250	100	− 3.0	3.5	2.55	—	0.49	25.0	—	—	—	7 B	15/-
	,, ..	.. osc.			250	—	—	3.65	—	—	—	—	—	—	—		
	X 41 (TH)	.. hex.	4.0	1.2	250	80	− 1.5	2.3	2.8	0.75	0.64	12.0	7.0	21.5	0.046	7 B	15/-
	,,	.. osc.			150	—	—	2.2	—	—	—	—	17.0	8.5	3.56		
	X 31 (TH)	.. hex.	13.0	0.3	250	80	− 1.5	2.3	2.8	0.75	0.64	12.0	7.0	21.5	0.046	7 B	15/-
	,,	.. osc.			150	—	—	2.2	—	—	—	—	17.0	8.5	3.56		
	X 30 } (H)	.. tet.	13.0	0.3	250	80	− 3.0	4.0	2.0	0.2	0.8	10.0	—	—	—	7 B	15/-
	X 32 }	.. osc.			150	—	—	3.0	—	—	—	—	—	—	—		
MAZDA ..	TP 22 (TP)	.. pent.	2.0*	0.25	150	60	− 1.5	1.2	0.4	1.6	0.5	3.0	8.5	10.0	0.03	9 A	14/-
	,,	.. osc.			150	—	—	0.7	—	0.024	1.4	—	4.75	6.5	4.75		
	ACTP (TP)	.. pent.	4.0	1.25	250	200	− 5.0	6.5	2.5	0.9	0.7	3.0	7.5	7.75	0.01	9 B	15/-
	,,	.. osc.			200	—	—	1.5	—	0.0215	1.4	—	5.5	4.25	2.5		
	ACTH 1 (TH)	.. hex.	4.0	1.3	250	100	− 3.0	3.0	6.0	1.6	0.75	9.0	9.75	11.5	0.0025	7 B	15/-
	,,	.. osc.			250	—	—	4.0	—	0.003	5.3	—	10.25	4.0	2.25		
	TP 1340 (TP)	.. pent.	13.0	0.4	250	200	− 5.0	6.5	2.5	0.9	0.7	3.0	8.0	8.5	0.06	9 B	15/-
	,,	.. osc.			200	—	—	1.5	—	0.0215	1.4	—	5.75	4.5	2.5		
	TP 2620 (TP)	.. pent.	26.0	0.2	250	200	− 5.0	6.5	2.5	0.9	0.65	3.0	8.0	7.75	0.1	9 B	15/-
	,,	.. osc.			200	—	—	1.5	—	0.0215	1.4	—	5.75	4.25	2.5		
	TH 2620 (TP)	.. hex.	26.0	0.2	250	100	− 3.0	3.0	6.0	1.6	0.75	9.0	9.75	11.5	0.0025	7 B	15/-
	,,	.. osc.			250	—	—	4.0	—	0.003	5.3	—	10.25	4.0	2.25		
MULLARD ..	FC 2 (O)	.. pent.	2.0*	0.125	150	70	0	0.8	0.75	—	0.2	13.0	9.9	14.5	0.057	7 A	14/-
	,,	.. osc.			150	—	—	—	—	—	—	—	7.0	6.4	—		
	FC 4 (O)	.. pent.	4.0	0.65	250	70	− 1.5	1.6	3.8	1.6	0.6	12.0	9.0	12.5	0.034	7 B	15/-
	,,	.. osc.			90	—	—	2.0	—	—	—	—	9.4	6.1	—		
	TH 4 (TH)	.. hex.	4.0	1.0	250	70	− 1.5	4.0	6.0	1.5	1.0	20.0	7.4	14.3	0.1	7 B	15/-
	,,	.. osc.			100	—	—	6.0	—	—	1.2	—	—	2.8	1.8		
	FC 13 C (O)	.. pent.	13.0	0.2	200	70	− 1.5	1.6	3.8	1.6	0.6	12.0	9.0	12.5	0.034	7 B	15/-
	,,	.. osc.			90	—	—	2.0	—	—	—	—	9.4	6.1	—		
	TH 13 C (TH)	.. hex.	13.0	0.31	250	70	− 1.5	4.0	6.0	1.5	1.0	20.0	7.4	14.3	0.1	7 B	15/-
	,,	.. osc.			100	—	—	6.0	—	—	1.2	—	—	2.8	1.8		
	TH 21 C (TH)	.. hex.	21.0	0.2	250	70	− 1.5	4.0	6.0	1.5	1.0	20.0	7.4	14.3	0.1	7 B	15/-
	,,	.. osc.			100	—	—	6.0	—	—	1.2	—	—	2.8	1.8		
OSTAR-GANZ .	G 5 (H) .	.. tet.	100/250	0.024	250	60	− 1.7	2.5	3.0	1.5	0.6	8.0	3.0	15.0	0.07	C 7 A	—
	,, .	.. osc.			140	—	—	3.0	—	—	—	—	—	—	—		
362	AC FC 4 (H)	.. tet.	4.0	1.0	250	80	0	7.0	—	—	—	—	—	—	—	7 B	15/-
TRIOTRON ..	O 202 (O)	.. pent.	2.0*	0.14	135	45	0	0.6	2.5	2.5	0.25	11.3	9.1	14.3	0.07	7 A	11/6
	O 406 (O)	.. pent.	4.0	0.65	250	70	− 1.5	1.3	3.0	1.5	0.6	11.3	9.0	12.5	0.06	7 B	12/-
	O 1307 (O)	.. pent.	13.0	0.2	200	70	− 1.5	0.8	3.0	1.5	0.6	11.3	9.0	12.5	0.06	7 B & Ct 8 A	12/-
TUNGSRAM ..	VO 2 (O) ..	.. pent.	2.0*	0.13	135	45	0	0.7	0.6	2.0	0.27	11.0	9.1	14.3	0.07	7 A	14/-
	,, ..	.. osc.			135	—	—	1.3	—	—	—	—	6.6	8.7	—		
	VO 4 (O) ..	.. pent.	4.0	0.65	250	70	− 1.5	1.6	3.8	1.0	0.6	12.0	9.0	12.5	0.06	7 B	15/-
	,, ..	.. osc.			90	—	—	2.0	—	—	—	—	9.4	6.1	—		
	TX 4 (TH)	.. hex.	4.0	1.0	300	80	− 1.5	5.5	6.0	1.5	1.0	17.0	7.5	14.5	—	7 B	15/-
	,,	.. osc.			150	—	—	4.0	—	—	1.2	—	—	2.8	1.8		
	VO 6 (O) ..	.. pent.	6.3	0.2	250	60	− 2.0	1.1	1.0	2.0	0.45	12.0	8.4	11.3	—	Ct. 8 A	18 -
	,, ..	.. osc.			200	—	—	—	—	—	—	—	—	—	—		
	VO 13 (O)	.. pent.	13.0	0.2	250	70	− 1.5	1.6	3.5	1.0	0.6	12.0	8.7	12.5	0.06	7 B	15/-
	,,	.. osc.			90	—	—	2.5	—	—	—	—	9.1	6.0	—		
	TX 21 (TH)	.. hex.	21.0	0.2	250	80	− 1.5	5.5	6.0	1.5	1.0	17.0	7.6	14.5	—	7 B	15/-
	,,	.. osc.			150	—	—	4.0	—	—	1.2	—	—	2.9	1.7		

FREQUENCY-CHANGERS—(*Continued*)

Type.			Heater.		Volts.			Current (mA.).		AC Resistance (MΩ).	Conversion Conductance (mA/V.).	Opt. Osc. Volts (Peak).	Capacities (mmfds.).			Base.	Price.
			Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.				Input.	Output.	Grid-Anode.		
AMERICAN ..	1 A 6 (H)	.. tet.	2.0*	0.06	180	67.5	– 3.0	1.3	2.4	0.5	0.3	—	10.5	9.0	0.25	A 6 A	—
	"	.. osc.			135	—	—	2.3	—	—	0.425	—	5.0	6.0	0.8		
	1 C 6 (H)	.. tet.	2.0*	0.12	180	67.5	– 3.0	1.5	2.0	0.75	0.325	—	10.0	10.0	0.3	A 6 A	—
	"	.. osc.			135	—	—	3.3	—	—	1.0	—	6.0	6.0	1.5		
	2 A 7 (H)	.. tet.	2.5	0.8	250	100	– 3.0	3.5	2.2	0.36	0.52	—	8.5	9.0	0.3	A 7 A	—
	"	.. osc.			200	—	—	4.0	—	—	—	—	7.0	5.5	1.0		
	6 A 7 (H)	.. tet.	6.3	0.3	250	100	– 3.0	3.5	2.2	0.36	0.52	—	8.5	9.0	0.3	A 7 A	—
	"	.. osc.			200	—	—	4.0	—	—	—	—	7.0	5.5	1.0		
	6 A 8 (H)	.. tet.	6.3	0.3	250	100	– 3.0	3.3	3.2	0.36	0.5	—	12.5	12.5	0.03	A 8 A	—
	"	.. osc.			250	—	—	4.0	—	—	—	—	6.5	5.0	0.8		
	6 F 7 (TP)	.. pent.	6.3	0.3	250	100	–10.0	2.8	0.6	2.0	0.3	7.0	3.2	12.5	0.008	A 7 A	—
	"	.. osc.			100	—	—	2.4	—	0.0178	0.45	—	2.5	3.0	2.0		
	6 L 7 ..	.. —	6.3	0.3	250	150	– 6.0	3.3	8.3	1.0	0.35	18.0	8.5	12.5	0.00005	A 8 B	—
	6 D 8 (H)	.. tet.	6.3	0.15	250	100	– 3.0	—	—	0.32	0.5	—	8.0	11.0	0.3	A 8 A	—
	"	.. osc.			250	—	—	—	—	—	1.0	—	6.0	5.5	1.0		

SCREEN-GRID VALVES

Type.		Heater.		Volts.			Currents (mA.).		AC Resistance (MΩ).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.			Input.	Output.	Grid-Anode.		
BRIMAR ..	8 A 1 (P)	4.0	1.0	250	100	–1.5	3.5	1.2	0.6	4.0	—	—	—	5 B	12/6
	8 D 2 (P) . ..	13.0	0.2	250	100	–3.0	2.5	0.5	1.5	1.25	4.0	10.0	0.005	7 D	12/6
CLARION ..	SG 2	2.0*	0.11	150	80	—	2.5	0.75	0.3	1.0	—	—	—	4 B	3/9
	ACSG	4.0	1.0	200	85	—	3.0	1.0	0.35	2.0	—	—	—	5 B	4/6
	ACHP (P)	4.0	1.0	200	100	—	4.5	1.3	—	2.5	—	—	—	7 D	6/6
	ADHP (P)	20.0	0.18	200	100	—	5.0	2.0	—	2.8	—	—	—	7 D	6/6
COSSOR	215 SG	2.0*	0.15	150	80	—	0.7	—	0.3	1.1	8.3	5.2	0.001	4 B	11/–
	220 SG	2.0*	0.2	150	80	—	0.7	—	0.2	1.6	—	—	—	4 B	11/–
	210 SPT (P) ..	2.0*	0.1	150	80	—	2.0	—	0.6	1.3	8.0	6.4	0.005	7 C	11/–
	MSGHA	4.0	1.0	200	100	—	2.0	—	0.5	2.0	—	—	—	5 B	12/6
	41 MSG	4.0	1.0	200	80	—	0.8	—	0.4	2.5	—	—	—	5 B	17/6
	MSGLA . ..	4.0	1.0	200	100	—	5.2	—	0.2	3.75	—	—	—	5 B	12/6
	MS/Pen (P) ..	4.0	1.0	200	100	—	4.5	1.3	0.8	3.5	10.0	8.0	0.003	7 D	12/6
	MS/Pen A (P) ..	4.0	1.0	200	150	—	9.0	5.0	0.09	4.0	—	—	—	7 D	17/6
	13 SPA (P) ..	13.0	0.2	200	100	—	5.0	1.3	1.0	2.5	5.2	9.1	0.003	7 D	12/6
DARIO	PF 462 (P) ..	2.0*	0.18	150	150	—	3.0	1.0	0.55	1.85	5.3	5.6	0.003	7 C	10/–
	TB 622 . ..	2.0*	0.18	150	90	–0.5	2.0	0.5	0.35	1.4	—	—	0.008	4 B	9/6
	TE 424	4.0	1.0	200	100	–1.3	1.5	0.6	0.8	0.9	9.0	6.0	0.002	5 B	11/6
	TE 524	4.0	1.0	200	100	–2.0	3.0	1.0	0.45	2.0	12.0	7.0	0.002	5 B	11/6
	TE 464 (P) ..	4.0	1.1	200	100	–2.0	3.0	1.5	1.45	3.5	12.0	10.0	0.001	7 D & 5 B	11/6
	TE 444 (SD)	4.0	1.1	200	33	–2.3	0.35	0.25	3.0	3.0	11.0	7.0	0.003	C 7	13/6
	TF 713 (P) ..	13.0	0.2	200	100	–2.0	3.0	1.1	2.0	2.4	6.6	7.7	0.003	7 E	11/6
EVER-READY ..	K 40 B	2.0*	0.18	135	90	—	2.0	0.4	0.33	1.3	—	—	0.008	4 B	11/–
	A50 A (P)	4.0	1.0	200	100	—	3.0	1.2	2.2	2.3	—	—	0.002	5 B	12/6
	A 50 B (P) ..	4.0	0.65	250	250	–1.5	6.0	2.4	—	3.5	6.9	7.8	0.003	7 E	12/6
	C 50 B (P)	13.0	0.2	200	200	–1.5	3.5	2.0	—	3.5	6.9	7.8	0.003	7 E	12/6
FERRANTI ..	SPT 4 A (P) ..	4.0	1.0	250	100	–1.5	2.0	1.0	3.0	2.3	10.6	8.0	0.002	7 D	12/6

SCREEN-GRID VALVES—(*Continued*)

Type.		Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Screen.	Volts. Grid.	Currents (mA.). Anode.	Currents (mA.). Screen	AC Resistance (MΩ).	Mutual Conductance (mA/V.).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
GRAHAM-FARISH	SG 2	2.0*	0.15	150	80	0	2.0	0.75	0.25	1.0	7.9	9.2	0.002	4 B	11/-
	SX 2	2.0*	0.2	150	80	0	2.25	0.6	0.33	1.5	9.0	9.4	0.002	4 B	11/-
	SWG 2	2.0*	0.2	150	80	0	2.25	0.6	0.33	1.5	—	—	0.002	4 C	13/6
	HP 2 (P)	2.0*	0.15	150	70	0	1.5	0.3	0.5	1.2	8.4	8.0	0.004	7 C	11/-
	AC/SG	4.0	1.0	200	80	−1.5	2.4	0.3	0.225	3.3	11.2	7.0	0.005	5 B	17/6
	AC/HG	4.0	1.0	200	80	−1.5	4.5	0.5	0.8	3.5	11.6	7.0	0.005	5 B	12/6
	AC/HP (P) ..	4.0	1.0	200	100	−1.5	3.0	1.0	0.85	3.2	12.9	9.3	0.003	7 D	17/6
HIVAC	XSG	2.0*	0.066	120	60	0	2.2	0.5	0.5	0.75	1.7	2.7	0.02	Sm. 4 B***	15/6
	SG 215	2.0*	0.15	150	75	−1.5	2.7	0.8	0.25	1.0	7.9	9.2	0.002	4 B	9/6
	SG 220	2.0*	0.2	150	70	−1.5	2.4	0.9	0.33	1.5	9.0	9.4	0.002	4 B	9/6
	SG 220 SW	2.0*	0.2	150	70	−1.5	2.4	0.9	0.33	1.5	5.4	9.9	0.002	4 C	12/6
	HP 215 (P)	2.0*	0.15	150	70	−1.5	1.5	0.3	0.5	1.2	8.4	8.0	0.004	7 C	9/6
	AC/SL	4.0	1.0	200	80	−1.0	3.8	0.4	0.225	3.3	11.2	7.0	0.0015	5 B	10/6
	AC/SH	4.0	1.0	200	80	−1.5	7.4	0.5	0.5	3.5	11.6	7.0	0.0015	5 B	10/6
	AC/HP (P) ..	4.0	1.0	200	100	−2.0	4.2	1.4	0.35	3.2	12.9	9.3	0.003	5 B or 7 D	10/6
LISSEN	SG 215	2.0*	0.15	150	80	—	1.5	0.25	0.9	1.1	—	—	0.001	4 B	11/-
	ACSG	4.0	1.0	200	80	—	7.0	0.5	0.34	4.0	—	—	0.001	5 B	12/6
MARCONI and OSRAM	S 23	2.0*	0.1	150	70	0	1.4	0.8	0.3	1.1	8.35	9.0	0.003	4 B	11/-
	S 24	2.0*	0.15	150	70	0	1.4	1.0	0.3	1.4	9.3	8.9	0.004	4 B	11/-
	MS 4	4.0	1.0	200	70	−1.5	2.4	0.3	0.5	1.1	9.9	4.8	0.002	5 B	12/6
	MS 4 B	4.0	1.0	200	80	−1.0	3.4	1.2	0.35	3.2	12.7	5.6	0.002	5 B	12/6
	MSP 4 (P)	4.0	1.0	250	100	−1.75	3.0	1.0	1.0	4.0	14.0	10.0	0.01	7 D or 5 B	12/6
	MSP 41 (P) ..	4.0	1.0	250	240	−4.0	8.5	3.2	—	3.2	14.0	10.0	0.01	7 D or 5 B	15/-
MAZDA	S 215 A	2.0*	0.15	150	60	0	1.9	0.3	0.72	1.1	9.5	12.5	0.002	4 B	11/-
	SP 215 (P)	2.0*	0.15	150	80	−1.5	2.1	0.7	0.8	1.6	11.0	8.5	0.007	7 C	11/-
	SP 210 (P)	2.0*	0.1	120	120	−1.0	1.1	0.33	2.0	1.2	10.0	11.0	0.005	7 C	11/-
	ACSG	4.0	1.0	200	60	−1.5	4.5	0.8	0.895	1.9	10.0	10.0	0.003	5 B	12/6
	ACS 2	4.0	1.0	200	80	−1.5	7.0	0.8	0.6	5.0	12.0	12.0	0.0015	5 B	12/6
	ACS 2 Pen (P) ..	4.0	1.0	250	100	−2.0	6.5	2.2	1.5	5.5	13.5	8.0	0.005	7 D	12/6
	ACSP 1 (P) ..	4.0	1.0	250	200	−3.0	4.9	4.1	—	3.0	12.75	9.0	0.0035	7 D	12/6
	SP 2220 (P) ..	20.0	0.2	250	200	−3.0	4.9	4.1	—	3.0	12.75	9.0	0.0035	7 D	12/6
MULLARD ..	PM 12 A	2.0*	0.18	135	90	0	2.0	0.4	0.33	1.3	—	—	0.008	4 B	11/-
	PM 12	2.0*	0.15	135	75	0	4.0	1.0	0.18	1.1	—	—	0.008	4 B	11/-
	SP 2 (P)	2.0*	0.18	135	135	0	3.0	1.25	—	1.9	—	—	0.01	7 C	11/-
	S 4 VA	4.0	1.0	200	110	−1.5	2.75	0.7	0.5	2.0	—	—	0.003	5 B	12/6
	S 4 VB	4.0	1.0	200	110	−1.5	3.0	0.7	0.45	2.0	—	—	0.003	5 B	12/6
	SP 4 (P)	4.0	1.0	200	100	−1.5	3.0	1.2	2.2	2.3	—	—	0.002	5 B or 7 D	12/6
	SP 4 B (P)	4.0	0.65	250	250	−1.5	6.0	2.4	—	3.5	6.9	7.8	0.003	7 E	12/6
	TSP 4 (P)	4.0	1.3	200	200	−2.5	8.0	1.5	—	4.73	9.1	7.5	0.0117	7 E	17/6
	AP 4 Acorn (P) ..	4.0	0.2	250	100	−3.0	2.0	0.7	3.5	1.4	3.0	2.7	0.02	—	60/-
	SP 13 C (P) ..	13.0	0.2	200	200	−1.5	3.5	2.0	—	3.0	6.9	7.8	0.003	7 E	12/6
OSTAR-GANZ ..	S 25	100/250	0.024	250	100	−2.0	4.0	0.4	0.25	3.8	—	—	0.001	C 7 B	—
	S 100	100/250	0.024	250	100	−1.0	1.0	0.2	1.0	3.5	—	—	0.001	C 7 B	—
	H 3 (P)	100/250	0.024	250	100	−2.0	1.6	0.6	3.5	3.5	11.0	12.0	0.005	C 7 C	—
PIX	25	2.0*	0.15	150	75	—	2.5	0.5	0.23	1.0	—	—	—	4 B	8/6
	450 AC	4.0	1.0	200	100	—	3.5	0.75	0.2	3.0	—	—	—	5 B	10/6
362	SG 2	2.0*	0.2	150	80	—	1.5	1.0	0.4	1.5	—	—	0.01	4 B	7/6
	ACSG 4	4.0	1.0	250	80	—	6.0	1.0	0.4	2.5	—	—	0.009	5 B	10/6
	ACHM 4 (P) ..	4.0	1.0	350	150	—	15.0	4.0	0.2	2.5	—	—	0.012	5 B	13/-
TRIOTRON ..	S 218 (P)	2.0*	0.18	150	150	0	3.0	1.0	0.55	1.85	5.3	5.6	0.002	7 C	8/6
	S 215	2.0*	0.15	120	100	−0.5	2.5	0.25	0.33	1.5	—	—	0.05	4 B	8/6
	S 435 N (P) ..	4.0	1.1	200	100	−2.0	3.0	0.5	1.45	3.5	12.0	10.0	0.002	7 D or 5 B	10/-
	S 410 N	4.0	1.0	200	60	−2.0	4.0	0.5	0.4	1.0	9.0	6.0	0.02	5 B	10/-
	B 430 N (SD) ..	4.0	1.0	200	33	−2.5	0.35	0.25	3.3	3.0	11.0	7.0	0.003	C 7	13/6

SCREEN-GRID VALVES—(*Continued*)

	Type.	Heater.		Volts.			Currents (mA.).		AC Resistance (MΩ).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.			Input.	Output.	Grid-Anode.		
TRIOTRON—contd.	S 1324 (P)	13.0	0.2	250	100	−2.0	3.0	1.0	2.0	2.4	6.6	7.7	0.003	7 E	10/-
	S 1328 (P)	13.0	0.2	200	100	−2.0	3.0	1.0	1.5	3.0	8.0	6.8	0.002	Ct. 8 B	10/-
	S 2035 N (P) ..	20.0	0.18	200	100	−2.0	3.0	0.25	1.45	3.5	12.0	10.0	0.002	5 B	10/-
TUNGSRAM ..	SS 210	2.0*	0.12	150	75	—	1.5	0.3	1.5	1.4	9.0	8.5	0.003	4 B	10/-
	HP 210 (P).. ..	2.0*	0.12	150	150	—	1.9	0.7	2.5	1.9	9.0	8.5	0.003	7 C	11/-
	SP 2 B (P)	2.0*	0.05	135	135	−0.5	1.2	0.4	1.5	0.8	5.3	5.0	0.006	7 N	11/-
	AS 4120	4.0	1.0	200	100	−2.0	3.0	0.8	0.3	3.0	—	—	0.001	5 B	12/6
	HP 4101 (P) ..	4.0	1.0	250	100	−3.0	3.5	1.8	2.0	3.5	—	—	0.002	7 D	12/6
	SP 4 B (P)	4.0	0.65	250	250	−2.0	4.5	1.8	2.0	4.0	6.4	7.6	0.003	7 E	12/6
	SP 6 (P)	6.3	0.2	250	100	−2.0	3.0	1.0	1.75	2.0	4.7	7.5	0.003	Ct. 8 B	15/-
	SP 13 (P)	13.0	0.2	250	100	−2.0	3.0	1.5	1.5	2.4	6.4	7.6	0.003	7 E	12/6
	SP 13 B (P) ..	13.0	0.2	200	200	−1.5	2.0	1.7	1.5	4.0	6.4	7.6	0.003	7 E	12/6
AMERICAN ..	32	2.0*	0.06	135	67.5	−3.0	1.7	0.4	0.95	0.64	5.3	10.5	0.015	A 4 B	—
	1 B 4	2.0*	0.06	180	67.5	−3.0	1.7	0.4	1.2	0.65	4.6	11.0	0.007	A 4 B	—
	24 A	2.5	1.75	250	90	−3.0	4.0	1.7	0.6	1.05	5.3	10.5	0.007	A 5 B	—
	57 (P)	2.5	1.0	250	100	−3.0	2.0	0.5	1.5	1.225	5.0	6.5	0.007	A 6 B	—
	22	3.3*	0.132	135	67.5	−1.5	3.7	1.3	0.325	0.5	3.5	10.0	0.02	A 4 B	—
	77 (P)	6.3	0.3	250	100	−3.0	2.3	0.5	1.5	1.25	4.7	11.0	0.007	A 6 B	—
	36	6.3	0.3	250	90	−3.0	3.2	1.7	0.55	1.08	9.2	3.7	0.007	A 5 B	—
	6 C 6 (P)	6.3	0.3	250	100	−3.0	2.0	0.5	1.5	1.225	5.0	6.5	0.01	A 6 B	—
	6 J 7 (P)	6.3	0.3	250	100	−3.0	2.0	0.5	1.5	1.225	7.0	12.0	0.005	A 8 C	—

VARIABLE-MU VALVES

	Type.	Heater.		Volts.			Currents (mA.).		AC Resistance (MΩ).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.			Input.	Output.	Grid-Anode.		
BRIMAR ..	9 A 1 (P)	4.0	1.0	250	100	−1.5	5.0	2.0	0.6	4.25	—	—	—	5 B	12/6
	9 A 3 (P)	4.0	0.65	250	125	−2.0	10.0	3.0	0.6	1.8	4.0	10.0	0.005	7 D	12/6
	9 D 2 (P)	13.0	0.2	250	125	−2.0	10.0	3.0	0.6	1.8	4.0	10.0	0.005	7 E	12/6
CLARION ..	VS 2	2.0*	0.11	150	80	0	4.5	1.2	—	1.2	—	—	—	4 B	3/9
	VHP 2 (P)	2.0*	0.15	150	60	0	3.5	0.75	—	1.0	—	—	—	7 C	4/6
	ACVS	4.0	1.0	200	90	−1.5	7.0	1.5	—	2.0	—	—	—	5 B	4/6
	ACVHP (P)	4.0	1.0	200	100	−1.5	4.5	1.5	—	2.2	—	—	—	7 D	6/6
	VHP 13 (P)	13.0	0.2	200	100	−1.5	4.0	1.5	—	2.0	—	—	—	7 D	6/6
	ADVHP (P) ..	20.0	0.18	200	100	−1.5	5.5	2.3	—	2.5	—	—	—	7 D	6/6
COSSOR	220 VS	2.0*	0.2	150	80	0	1.6	—	0.4	1.6	—	—	—	4 B	11/-
	220 VSG	2.0*	0.2	150	80	0	2.6	—	0.11	1.6	—	—	—	4 B	11/-
	210 VPT (P) ..	2.0*	0.1	150	80	0	2.9	0.75	0.6	1.1	8.2	6.7	0.008	7 C	11/-
	MVSG	4.0	1.0	200	80	−1.5	7.8	0.75	0.2	2.5	—	—	—	5 B	12/6
	MVS/Pen (P) ..	4.0	1.0	200	100	0	4.2	1.3	0.6	3.0	9.2	8.5	0.003	7 D	12/6
	13 VPA (P)	13.0	0.2	200	100	0	9.0	2.2	0.8	1.8	5.2	9.0	0.003	7 D	12/6
DARIO	PF 472 (P)	2.0*	0.18	150	150	−0.5	2.5	0.5	0.5	1.7	5.7	5.1	0.002	7 C	10/-
	TB 452	2.0*	0.15	150	75	−0	4.0	0.4	0.35	1.5	—	—	0.002	4 B	9/6
	TE 474 (P)	4.0	1.1	200	100	−1.5	4.5	2.0	1.0	3.5	12.0	10.0	0.002	7 D & 5 B	11/6
	TE 554	4.0	1.0	200	100	−2.5	3.0	1.0	0.3	3.0	11.0	8.0	0.002	5 B	11/6
	TF 313 (P)	13.0	0.2	200	100	−3.0	8.0	2.6	1.0	2.8	8.0	7.5	0.001	7 E	11/6

VARIABLE-MU VALVES—(*Continued*)

Type.		Heater.		Volts.			Currents (mA.).		AC Resistance (MΩ).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.			Input.	Output.	Grid-Anode.		
EVER-READY ..	K 40 N	2.0*	0.18	150	90	0	2.5	0.5	—	1.4	—	—	0.008	4 B	11/-
	K 50 M (P)	2.0*	0.18	150	150	0	3.7	0.5	0.75	1.7	—	—	0.007	7 C	11/-
	A 50 N (P)	4.0	1.2	200	100	−1.5	5.0	2.3	—	3.27	—	—	0.0025	7 D	12/6
	A 50 P (P)	4.0	0.65	250	250	−3.0	11.5	4.25	—	2.0	5.35	8.05	0.0023	7 E	12/6
	A 40 M	4.0	1.0	200	110	−1.5	6.0	0.8	—	2.5	—	—	0.003	5 B	12/6
	A 50 M (P)	4.0	1.0	200	100	−1.5	6.0	2.4	—	2.1	—	—	0.0025	7 D	12/6
	C 50 N (P)	13.0	0.2	200	200	−2.0	9.5	2.7	—	2.0	5.35	8.05	0.0023	7 E	12/6
FERRANTI ..	VPT 4 B (P).. ..	4.0	1.0	250	100	−2.0	6.0	3.0	1.8	3.2	10.6	8.2	0.002	7 D	12/6
	VPT 4 (P)	4.0	1.0	250	100	−3.0	5.5	2.0	1.0	2.0	8.8	8.4	0.002	5 B	12/6
	VPTS (P)	13.0	0.3	250	100	−3.0	5.5	2.0	1.0	2.0	8.8	8.4	0.002	7 D	12/6
	VPTA (P)	13.0	0.2	250	100	−2.0	4.2	2.0	1.0	2.0	9.0	9.0	0.002	7 D	12/6
GRAHAM-FARISH	VS 2	2.0*	0.15	150	75	0	6.0	1.5	0.11	1.0	7.8	9.2	0.002	4 B	11/-
	VP 2 (P)	2.0*	0.15	150	70	0	3.75	0.75	0.4	1.25	8.4	8.0	0.004	7 C	11/-
	AC/VG	4.0	1.0	200	80	0	5.0	0.7	0.4	3.0	11.2	7.4	0.0015	5 B	17/6
	AC/VS	4.0	1.0	200	80	0	14.6	1.6	0.45	3.3	11.5	7.5	0.0015	5 B	17/6
	AC/VP (P)	4.0	1.0	200	100	0	6.0	2.0	1.0	3.0	12.9	9.4	0.003	7 D	17/6
HIVAC	VS 215	2.0*	0.15	150	75	0	6.0	1.7	0.11	1.0	7.8	9.2	0.002	4 B	9/6
	VP 215 (P)	2.0*	0.15	150	70	0	3.75	0.75	—	1.25	8.4	8.0	0.004	4 B or 7 C	9/6
	AC/VS	4.0	1.0	200	80	−1.5	4.4	0.6	0.225	3.0	11.2	7.4	0.0015	5 B	10/6
	AC/VH	4.0	1.0	200	80	−1.5	9.3	1.6	0.45	3.3	11.5	7.4	0.0015	5 B	10/6
	AC/VP (P)	4.0	1.0	200	100	−1.5	5.7	2.3	—	3.0	12.9	9.4	0.003	5 B or 7 D	10/6
	VP 13 (P)	13.0	0.3	200	100	−1.5	6.3	2.0	—	3.0	12.6	9.3	0.003	7 D	10/6
LISSEN	SG 2 V	2.0*	0.15	150	80	0	4.0	0.25	0.4	1.2	—	—	0.001	4 B	11/-
	ACSGV	4.0	1.0	200	80	−1.5	6.0	0.5	0.3	4.0	—	—	0.001	5 B	12/6
MARCONI and OSRAM	VS 24	2.0*	0.15	150	75	0	4.4	0.3	0.25	1.5	9.2	8.73	0.003	4 B	11/-
	VP 21 (P)	2.0*	0.1	150	60	0	2.8	0.7	1.0	1.1	11.5	9.0	0.03	7 C	11/-
	VMS 4	4.0	1.0	200	80	−0.5	12.0	2.0	0.25	2.2	9.9	4.8	0.002	5 B	12/6
	VMS 4 B	4.0	1.0	200	80	−0.5	6.7	1.3	0.25	2.9	9.9	4.8	0.002	5 B	12/6
	VMP 4 G (P) ..	4.0	1.0	250	100	−2.0	8.0	5.0	1.0	2.7	14.0	8.7	0.0026	7 D	12/6
	W 42 (P)	4.0	0.6	250	100	−3.0	7.6	1.85	—	1.5	—	—	—	7 E	12/6
	WD 40 (DD) (P) ..	4.0	1.0	250	100	−1.0	7.7	4.7	1.0	2.6	11.0	16.0	0.004	9 C	20/-
	W 30 (P)	13.0	0.3	250	250	−1.0	12.0	6.0	1.0	4.0	5.7	10.0	0.002	7 D	12/6
	W 31 (P)	13.0	0.3	250	100	−2.0	8.0	5.0	1.0	2.7	14.0	8.7	0.0026	7 D	12/6
	WD 30 (DD) (P) ..	13.0	0.3	250	100	−1.0	7.7	4.7	1.0	2.6	11.0	16.0	0.004	9 C	20/-
MAZDA	VP 215 (P)	2.0*	0.15	150	80	−1.5	2.5	0.8	0.8	1.8	10.5	8.5	0.007	7 C	11/-
	VP 210 (P)	2.0*	0.1	120	70	−1.5	1.8	0.63	0.89	1.4	8.75	11.0	0.004	7 C	11/-
	ACVP 1 (P)	4.0	0.65	250	250	−4.0	8.8	2.2	1.0	3.0	10.0	8.0	0.005	7 D	12/6
	ACVP 2 (P)	4.0	0.65	250	250	−4.0	8.8	2.2	1.0	3.0	6.75	10.0	0.0025	7 E	12/6
	VP 1321 (P) ..	13.0	0.2	250	250	−4.0	8.8	2.2	1.0	3.0	10.0	8.0	0.005	7 D	12/6
	VP 1322 (P) ..	13.0	0.2	250	250	−4.0	8.8	2.2	1.0	3.0	6.75	10.0	0.0025	7 E	12/6
MULLARD ..	PM 12 M	2.0*	0.18	135	90	0	1.8	0.4	—	1.2	—	—	0.008	4 B	11/-
	VP 2 (P)	2.0*	0.18	135	135	0	3.0	1.25	0.75	1.5	—	—	0.007	7 C	11/-
	MM 4 V	4.0	1.0	200	110	−1.5	6.0	0.8	—	2.5	—	—	0.003	5 B	12/6
	VM 4 V	4.0	1.0	200	100	−1.5	6.0	1.0	—	1.2	—	—	0.003	5 B	17/6
	VP 4 (P)	4.0	1.0	200	100	−1.5	6.0	2.4	—	2.1	—	—	0.0025	7 D	12/6
	VP 4 A (P)	4.0	1.2	200	100	−1.5	5.0	2.3	—	3.27	—	—	0.0025	7 D	12/6
	VP 4 B (P)	4.0	0.65	250	250	−3.0	11.5	4.25	—	2.0	5.35	8.05	0.0023	7 E	12/6
	VP 13 C (P) ..	13.0	0.2	200	200	−2.0	9.5	2.7	—	2.0	5.35	8.05	0.0023	7 E	12/6
	VP 13 A (P) ..	13.0	0.2	200	100	−2.0	4.5	1.5	1.0	2.2	—	—	0.003	Ct. 8 B	17/6
OSTAR-GANZ ..	MS 18	100/250	0.024	250	100	−2.0	5.0	4.0	0.5	3.0	—	—	—	C 7 B	—
	MS 70	100/250	0.024	250	100	−2.0	4.0	2.5	0.5	3.0	—	—	—	C 7 B	—
	V 3 (P)	100/250	0.024	250	100	−2.0	3.5	1.5	3.2	2.5	11.0	12.0	0.025	C 7 C	—
362	VS 2	2.0*	0.2	150	80	0	5.0	1.0	0.5	−1.2	—	—	—	4 B	7/6
	VP 2 C (P)	2.0*	0.2	150	80	0	4.0	1.5	0.4	−1.2	—	—	—	7 C	9/-
	ACVS 4	4.0	1.0	250	75	−1.0	6.0	2.0	0.4	2.0	—	—	—	5 B	9/-
	ACVP 4 (P)	4.0	1.0	250	150	−1.0	6.0	2.0	0.4	−3.0	—	—	—	7 D	12/6

VARIABLE-MU VALVES—(*Continued*)

Make	Type	Heater Volts	Heater Amps	Volts Anode	Volts Screen	Volts Grid	Currents (mA.) Anode	Currents (mA.) Screen	AC Resistance (MΩ).	Mutual Conductance (mA/V.).	Capacities (mmfds.) Input	Capacities (mmfds.) Output	Capacities (mmfds.) Grid-Anode	Base	Price
TRIOTRON	S 217 (P)	2.0*	0.18	150	150	−0.5	2.5	0.5	0.5	1.7	5.7	5.1	0.002	7 C	8/6
	S 213	2.0*	0.18	150	90	−0.5	3.0	0.3	0.3	1.3	—	—	0.05	4 B	8/6
	S 434 N (P)	4.0	1.1	200	100	−2.0	5.5	0.01	1.0	3.5	12.0	10.0	0.002	7 D or 5 B	10/-
	S 415 N	4.0	1.1	200	100	−2.0	6.0	1.0	0.3	1.2	11.0	8.0	0.003	5 B	10/-
	S 1323 (P)	13.0	0.2	200	100	−3.0	8.0	2.6	1.0	2.8	8.0	7.5	0.001	7 E & Ct. 8 B	10/-
	S 2034 N (P)	20.0	0.18	200	100	−2.0	5.5	0.01	0.6	3.5	12.0	10.0	0.002	5 B	10/-
TUNGSRAM	HP 211 (P)	2.0*	0.12	150	150	−0.5	2.6	0.6	2.0	1.7	—	—	0.003	7 C	11/-
	SE 211	2.0*	0.12	150	75	—	1.0	0.1	1.5	1.5	—	—	0.003	4 B	10/-
	VP 2 B (P)	2.0*	0.05	135	135	−0.5	1.0	0.3	1.3	0.65	5.7	5.1	0.006	7 N	11/-
	HP 4106 (P)	4.0	1.0	250	100	−2.0	5.0	1.25	1.2	3.5	—	—	0.002	7 D	12/6
	HP 4115 (P)	4.0	1.1	250	100	−2.0	4.3	1.5	1.4	3.2	—	—	0.002	7 D	12/6
	AS 4125	4.0	1.2	200	100	−1.5	3.0	0.8	0.25	3.0	—	—	—	5 B	12/6
	VP 4 B (P)	4.0	0.65	250	250	−1.0	10.0	2.5	0.8	4.0	6.4	7.6	0.003	7 E	12/6
	VP 6	6.3	0.2	250	100	−3.0	8.0	2.5	1.2	1.7	4.7	7.3	0.003	Ct. 8 B	15/-
	VP 13 (P)	13.0	0.2	250	100	−3.0	7.5	2.3	0.8	2.8	6.4	7.6	0.003	7 E	12/6
	HP 13 (P)	13.0	0.2	250	100	−3.25	8.0	2.9	0.8	2.8	—	—	—	7 E	12/6
	VP 13 B	13.0	0.2	200	200	−1.0	6.0	2.0	0.8	4.0	6.4	7.6	0.003	7 E	12/6
AMERICAN	34 (P)	2.0*	0.06	135	67.5	−3.0	2.8	1.0	0.6	0.6	6.9	11.5	0.015	A 4 B	—
	1 A 4	2.0*	0.06	180	67.5	−3.0	2.3	0.7	0.96	0.75	4.6	11.0	0.007	A 4 B	—
	1 F 6 (P) (DD)	2.0*	0.06	180	67.5	−1.5	2.0	0.6	1.0	0.65	—	—	—	A 6 K	—
	35	2.5	1.75	250	90	−3.0	6.5	2.5	0.4	1.05	5.3	10.5	0.007	A 5 B	—
	58 (P)	2.5	1.0	250	100	−3.0	8.2	2.0	0.8	1.6	4.7	6.5	0.007	A 6 B	—
	2 B 7 (P) (DD)	2.5	0.8	250	125	−3.0	9.0	2.3	0.65	1.125	3.5	9.5	0.007	A 7 B	—
	39, 44 (P)	6.3	0.3	250	90	−3.0	5.8	1.4	1.0	1.05	3.5	10.0	0.007	A 5 B	—
	78 (P)	6.3	0.3	250	125	−3.0	10.5	2.6	0.6	1.65	4.5	11.0	0.007	A 6 B	—
	6 B 7 (P) (DD)	6.3	0.3	250	125	−3.0	9.0	2.3	0.65	1.125	3.5	9.5	0.007	A 7 B	—
	6 K 7 (P)	6.3	0.3	250	125	−3.0	10.5	2.6	0.6	1.65	7.0	12.0	0.005	A 8 C	—
	6 D 6 (P)	6.3	0.3	250	100	−3.0	8.2	2.0	0.8	1.6	4.7	6.5	0.01	A 6 B	—
	6 S 7 (P)	6.3	0.15	250	100	−3.0	8.5	2.0	0.63	1.75	4.6	7.8	0.007	A 8 C	—

DIODES

Make	Type	Heater Volts	Heater Amps	Maximum Rating Input Volts RMS.	Maximum Rating Rect. Current (mA.)	No. of Diodes	Capacities (mmfds.) Anode 1 to Cathode	Capacities (mmfds.) Anode 2 to Cathode	Capacities (mmfds.) Anode 1 to Anode 2	Base	Price
BRIMAR	10 D 1	13.0	0.2	50	1.0	2	—	—	—	5 C	5/6
CLARION	ACD	4.0	1.0	200	0.8	2	—	—	—	5 C	2/9
	DD 13	13.0	0.2	200	0.8	2	—	—	—	5 C	2/9
COSSOR	220 DD	2.0	0.2	—	—	2	3.5	3.5	0.7	5 C	5/6
	DD 4	4.0	0.75	—	—	2	3.7	3.7	0.7	5 C	5/6
DARIO	TB 24	4.0	0.65	200	0.8	2	4.0	4.0	0.3	5 C	4/6
EVER-READY	A 20 B	4.0	0.65	200	0.8	2	4.5	4.5	0.3	5 C	5/6
	C 20 C	13.0	0.2	200	0.8	2	4.5	4.5	0.3	5 C	5/6
FERRANTI	SD	5.0	0.3	60	1.0	2	5.0	5.0	0.4	5 C	5/6
	ZD	7.0	0.2	60	1.0	2	5.0	5.0	0.4	5 C	5/6
HIVAC	AC/DD	4.0	1.0	—	—	2	3.0	2.4	0.4	5 C	4/6

DIODES—(*Continued*)

Type.		Heater.		Maximum Rating.		No. of Diodes.	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Input Volts RMS.	Rect. Current (mA.).		Anode 1 to Cathode.	Anode 2 to Cathode.	Anode 1 to Anode 2.		
MARCONI and OSRAM ..	D 41	4.0	0.3	25	0.13	2	3.5	2.5	0.5	5 C	5/6
	D 42	4.0	0.6	75	15.0	1	4.0	—	—	4 H	10/-
MAZDA	V 914	4.0	0.3	—	1.0	2	3.5	3.0	0.25	5 C	5/6
	DD 620	6.0	0.2	—	1.0	2	3.5	3.0	0.25	5 C	5/6
MULLARD	2 D 2	2.0	0.09	125	0.5	2	2.8	2.8	0.5	5 C	5/6
	2 D 4 A	4.0	0.65	200	0.8	2	4.5	4.5	0.3	5 C	5/6
	2 D 13 C	13.0	0.2	200	0.8	2	4.5	4.5	0.3	5 C	5/6
OSTAR-GANZ	B 2	100/250	0.024	200	15.0	2	—	—	—	C 7 D	—
TRIOTRON	D 400	4.0	0.65	200	0.8	2	4.0	4.0	0.3	5 C	4/6
	D 1300	13.0	0.2	200	0.8	2	4.0	4.2	0.3	5 C	4/6
TUNGSRAM	DD 4	4.0	0.65	200	0.8	2	4.0	4.0	0.5	5 C	4/6
	DD 6	6.3	0.2	150	0.6	2	3.5	3.5	0.5	Ct. 5 A	5/6
	DD 13	13.0	0.2	200	0.8	2	4.0	4.0	0.5	5 C	4/6
WESTINGHOUSE ..	W 4 (M)	—	—	17.0	0.25	1	—	—	—	—	5/-
	W 6 (M)	—	—	25.5	0.25	1	—	—	—	—	5/-
	WM 24 (M).. ..	—	—	17.0	0.25	2	—	—	—	—	10/-
	WM 26 (M).. ..	—	—	25.5	0.25	2	—	—	—	—	10/-
	WX 6 (M)	—	—	25.5	0.12	1	—	—	—	—	5/-
AMERICAN	6 H 6	6.3	0.3	100	4.0	2	4.6	4.6	0.02	A 8 D	—

TRIODE VALVES (AC Resistance greater than 7,000 ohms.)

Type.		Heater.		Volts.		Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Grid.				Input.	Output.	Grid-Anode.		
BRIMAR ..	HLA 2	4.0	1.0	200	– 2.5	6.0	9,000	5.5	—	—	—	5 A	9/6
	11 A 2 (DD)	4.0	1.0	200	– 2.0	3.0	18,000	2.8	—	—	—	7 G	12/6
	4 D 1	13.0	0.2	250	– 3.0	10.0	10,000	4.0	—	—	—	7 F	9/6
	11 D 3 (DD)	13.0	0.2	250	– 2.0	0.8	84,000	1.2	1.7	3.5	1.5	7 G	12/6
CLARION ..	H 2	2.0*	0.11	150	– 1.0	2.5	25,000	1.0	—	—	—	4 A	1/9
	HL 2	2.0*	0.11	150	– 4.0	4.0	12,500	1.2	—	—	—	4 A	1/9
	ACHF	4.0	1.0	200	– 3.0	3.0	14 000	2.5	—	—	—	5 A	3/3
	DDT 4 (DD)	4.0	1.0	200	– 3.0	3.0	14,000	2.5	—	—	—	7 G	7/6
	DDT 13 (DD) ..	13.0	0.2	200	– 3.0	3.0	14,000	2.5	—	—	—	7 G	7/6
	HF 13	13.0	0.2	200	– 3.0	3.0	14,000	2.5	—	—	—	5 A	3/3
	ADHF..	20.0	0.18	200	– 3.0	5.0	10,000	3.5	—	—	—	5 A	3/3
COSSOR	210 RC	2.0*	0.1	150	– 1.5	0.85	50,000	0.8	—	—	—	4 A	4/9
	210 HL	2.0*	0.1	150	– 3.0	1.6	22,000	1.1	7.0	7.0	4.0	4 A	4/9
	210 HF	2.0*	0.1	150	– 3.0	1.6	15,800	1.5	—	—	—	4 A	4/9
	210 DET	2.0*	0.1	150	– 4.5	3.0	13,000	1.1	—	—	—	4 A	4/9
	210 LF	2.0*	0.1	150	– 4.5	4.8	10,000	1.4	—	—	—	4 A	4/9
	41 MRC	4.0	1.0	200	– 2.0	2.7	19,500	2.6	—	—	—	5 A	14/-
	41 MH..	4.0	1.0	200	– 1.5	3.2	18,000	4.0	12.0	11.0	5.0	5 A	9/6
	41 MHF	4.0	1.0	200	– 3.0	3.0	14,500	2.8	—	—	—	5 A	14/-
	41 MHL	4.0	1.0	200	– 3.0	4.0	11,500	4.5	12.0	10.5	5.5	5 A	9/6
	41 MLF	4.0	1.0	180	– 5.5	9.0	7,950	1.9	—	—	—	5 A	14/-
	DDT (DD)	4.0	1.0	200	– 3.0	3.0	17,000	2.4	—	—	1.0	7 G	12/6
	13 DHA (DD) ..	13.0	0.2	250	– 1.5	1.0	83,300	1.5	—	—	—	7 G	12/6
	202 DDT (DD) ..	20.0	0.2	200	– 3.0	3.0	17,000	—	—	—	—	7 G	12/6

TRIODE VALVES—(*Continued*) (AC Resistance greater than 7,000 ohms.)

	Type.	Heater.		Volts.		Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Grid.				Input.	Output.	Grid-Anode.		
DARIO ..	TB 282	2.0*	0.1	150	– 1.5	2.0	22,000	1.3	—	—	—	4 A	3/6
	TB 172	2.0*	0.1	150	– 4.5	4.0	12,000	1.4	—	—	—	4 A	3/6
	TB 102	2.0*	0.1	150	– 6.0	5.0	8,000	1.25	—	—	—	4 A	3/6
	BBC 12	2.0*	0.14	135	– 4.5	2.5	10,500	1.5	—	—	—	5 E	6/6
	TE 244	4.0	1.0	200	– 3.5	6.0	10,000	2.4	6.0	7.0	2.0	5 A	8/6
	TBC 14	4.0	0.65	250	– 7.0	4.0	7,500	3.6	4.3	3.1	1.7	7 G	11/-
	TE 994	4.0	1.0	200	– 1.6	1.0	25,000	4.0	7.0	5.0	1.5	5 A	8/6
	TE 384	4.0	1.0	200	– 2.5	1.5	25,000	1.5	6.0	6.0	3.0	5 A	8/6
	TBC 113	13.0	0.2	200	– 5.0	4.0	7,500	3.6	4.3	3.1	1.7	7 G	11/-
EVER-READY ..	K 30 A	2.0*	0.1	150	– 3.0	1.5	22,500	0.8	—	—	—	4 A	4/9
	K 30 C	2.0*	0.1	150	– 1.5	2.0	20,000	1.4	6.0	4.0	5.0	4 A	4/9
	K 30 B	2.0*	0.1	150	– 7.5	4.0	12,000	0.9	—	—	—	4 A	4/9
	K 30 D and K 30 E ..	2.0*	0.1	150	– 4.5	4.0	12,000	1.5	11.9	9.7	8.8	4 A	4/9
	K 23 B (DD)	2.0*	0.12	150	– 1.5	1.4	26,000	1.2	2.3	7.6	2.7	5 E	9/-
	K 23 A (DD) ..	2.0*	0.1	135	– 4.5	2.0	12,000	1.4	—	—	—	5 E	9/-
	A 30 B	4.0	0.65	200	– 2.0	1.8	34,000	2.2	—	—	—	5 A	9/6
	A 30 D	4.0	0.65	200	– 4.0	4.0	12,500	3.2	9.5	7.7	3.4	5 A	9/6
	A 23 A (DD)	4.0	0.65	200	– 3.5	7.0	10,300	2.9	4.3	3.1	1.7	7 G	12/6
	C 30 B..	13.0	0.2	200	– 4.0	4.0	12,500	3.2	6.5	8.4	3.0	Ct. 8 C	9/6
FERRANTI ..	D 4	4.0	1.0	200	– 3.0	4.0	17,300‡	2.5‡	8.8	9.8	2.4	5 A	9/6
	H 4 D (DD)	4.0	1.0	200	– 3.0	4.5	16,000‡	2.3‡	5.2	7.9	2.0	7 G	12/6
	DS	13.0	0.3	200	– 3.0	4.0	17,300‡	2.5‡	8.8	9.8	2.4	7 F	9/6
	HSD (DD)	13.0	0.3	200	– 3.0	4.6	16,000‡	2.3‡	5.2	7.9	2.0	7 G	12/6
	DA	13.0	0.2	200	– 2.6	3.7	20,000‡	2.2‡	7.1	6.7	3.5	7 F	9/6
	HAD (DD)	13.0	0.2	200	– 2.5	3.3	22,300‡	2.0‡	6.5	7.4	2.5	7 G	12/6
GRAHAM-FARISH	DX 2	2.0*	0.1	150	– 3.0	3.5	12,000	1.4	4.0	4.5	4.4	4 A	4/9
	LF 2	2.0*	0.1	150	– 6.0	2.5	7,500	1.6	—	—	—	4 A	4/9
	AC/DX	4.0	1.0	200	– 3.0	5.0	10,000	3.5	6.8	7.0	5.5	5 A	9/6
	AC/LP..	4.0	1.0	200	–14.0	18.0	2,350	4.25	7.0	7.2	6.1	5 A	14/-
HIVAC ..	XD	2.0*	0.066	100	– 1.5	1.1	23,000	0.75	1.3	1.5	2.7	Sm. 4 A ***	10/6
	XL	2.0*	0.066	100	– 3.0	2.5	14,000	0.85	1.4	1.6	2.7	Sm. 4 A ***	10/6
	H 210	2.0*	0.1	150	– 3.0	1.1	22,000	1.15	4.3	4.5	4.8	4 A	3/9
	DDT 220 (DD) ..	2.0*	0.2	150	– 3.0	3.0	12,500	1.6	3.8	3.9	4.0	5 E	7/-
	D 210	2.0*	0.1	150	– 4.5	2.4	12,000	1.35	4.0	4.5	4.4	4 A	3/9
	D 210 SW	2.0*	0.1	150	– 4.5	2.4	12,000	1.35	2.4	4.5	2.6	4 I	5/6
	L 210	2.0*	0.1	150	– 6.0	4.2	7,500	1.6	—	—	—	4 A	3/9
	AC/DDT (DD) ..	4.0	1.0	200	– 4.0	5.0	15,000	2.3	2.4	5.1	3.5	7 G	10/6
	AC/HL	4.0	1.0	200	– 2.75	6.0	10,000	3.5	6.8	7.0	5.5	5 A	8/6
	DDT 13 (DD) ..	13.0	0.3	200	– 4.0	5.0	15,000	2.3	2.4	5.1	3.3	7 G	10/6
	HL 13	13.0	0.3	200	– 2.75	6.0	10,000	3.5	6.5	6.9	5.5	7 F	8/6
LISSEN ..	H 2	2.0*	0.1	150	– 1.5	1.0	45,000	1.1	—	—	—	4 A	4/9
	HL 2	2.0*	0.1	150	– 3.0	1.5	22,000	1.6	—	—	—	4 A	4/9
	L 2	2.0*	0.1	150	– 4.5	2.0	10,000	2.0	—	—	—	4 A	4/9
	L 2 D (SD) ..	2.0*	0.1	150	– 4.5	2.0	12,000	1.5	—	—	—	5	4/9
	ACHL	4.0	1.0	200	– 4.5	3.0	10,000	4.0	—	—	—	5 A	9/6
MARCONI and OSRAM	H 11	1.0*	0.1	100	– 2.0	0.6	30,000	0.5	2.6	3.25	4.0	Ct. 4 A	—
	L 11	1.0*	0.1	100	–12.0	2.8	12,500	0.4	2.0	3.9	5.0	Ct. 4 A	—
	HL 2	2.0*	0.1	150	– 3.0	1.8	18,000	1.5	5.2	3.5	8.4	4 A	4/9
	L 21	2.0*	0.1	150	– 6.0	2.2	8,900	1.8	—	—	—	4 A	4/9
	HD 22 (DD) ..	2.0*	0.2	150	– 3.0	2.0	18,000	1.5	1.8	15.0	3.6	5 E	9/-
	MH 4	4.0	1.0	200	– 3.0	4.5	11,000	3.6	7.1	4.4	6.5	5 A	9/6
	MH 41..	4.0	1.0	200	– 1.5	5.0	13,300	6.0	8.1	4.3	4.3	5 A	9/6
	MHL 4	4.0	1.0	200	– 6.0	7.0	8,000	2.5	4.27	1.8	3.7	5 A	13/6

TRIODE VALVES—(*Continued*) (AC Resistance greater than 7,000 ohms.)

Type.		Heater.		Volts.		Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Grid.				Input.	Output.	Grid-Anode.		
MARCONI and OSRAM—contd.	MHD 4 (DD) ..	4.0	1.0	200	– 3.0	3.0	18,200	2.2	2.5	5.2	4.1	7 G	12/6
	H 42	4.0	0.6	250	– 2.0	1.0	66,000	1.7	—	—	—	7 F	9/6
	DH 42 (DD)	4.0	0.6	250	– 3.0	1.1	58,000	1.2	—	—	—	7 G	12/6
	A 537	4.0	0.4	150	– 6.0	3.3	10,000	1.55	1.4	1.5	1.7	Special Side Ct.	50/–
	MH 40..	4.0	1.0	200	– 3.0	2.7	18,750	2.4	—	—	—	5 A	50/–
	HA 1 (Acorn).. ..	4.0	0.3	180	– 4.5	4.0	11,800	1.7	—	—	—	—	50/–
	H 30	13.0	0.3	250	– 1.7	5.5	13,300	6.0	5.2	8.4	2.9	7 F	9/6
	DH 30 (DD)	13.0	0.3	200	– 1.7	3.8	18,000	4.5	4.9	11.8	2.5	7 G	12/6
MAZDA	H 2	2.0*	0.1	150	—	2.5	45,000	1.1	4.5	4.5	4.5	4 A	4/9
	HL 2	2.0*	0.1	150	– 1.5	2.7	21,000	1.5	4.5	4.5	5.0	4 A	4/9
	L 2	2.0*	0.1	150	– 3.0	5.3	10,000	1.9	4.5	4.5	5.0	4 A	4/9
	HL 21 DD (DD) ..	2.0*	0.15	150	– 2.0	2.0	21,000	1.5	2.5	4.0	3.5	5 E	9/–
	L 21 DD (DD) ..	2.0*	0.15	150	– 5.0	2.3	10,000	1.8	2.5	4.0	3.25	5 E	9/–
	ACHL	4.0	1.0	200	– 3.5	5.0	11,700	3.0	7.75	11.0	3.25	5 A	9/6
	AC 2 HL	4.0	1.0	200	– 1.75	4.5	11,500	6.5	9.0	6.0	6.5	5 A	9/6
	ACHLDD (DD) ..	4.0	1.0	200	– 3.0	4.3	13,800	2.6	5.0	9.0	2.0	7 G	12/6
	ACHLDDD (TD) ..	4.0	1.0	200	– 3.0	4.9	13,000	2.7	3.75	6.25	2.0	9 G	16/6
	HL 1320	13.0	0.2	250	– 4.5	7.5	10,000	3.0	4.25	5.75	2.5	7 F	9/6
	HLDD 1320 (DD) ..	13.0	0.2	200	– 3.0	4.3	15,000	2.0	4.0	10.5	2.0	7 G	12/6
MULLARD ..	DA 1	2.0*	0.05	100	0	1.25	60,000	0.71	3.8	5.4	1.6	Sm. 4 A	15/–
	DA 2	2.0*	0.05	100	0	10.1	7,300	1.0	3.4	5.4	1.4	Sm. 4 A	15/–
	PM 1 HF	2.0*	0.1	135	– 3.0	1.5	22,500	0.8	—	—	—	4 A	4/9
	PM 1 LF	2.0*	0.1	135	– 6.0	3.25	12,000	0.9	—	—	—	4 A	4/9
	PM 1 HL	2.0*	0.1	135	– 1.5	2.0	20,000	1.4	6.0	4.0	5.0	4 A	4/9
	PM 2 DX	2.0*	0.1	135	– 4.5	2.0	12,000	1.5	11.9	9.7	8.8	4 A	4/9
	PM 2 DL	2.0*	0.1	135	– 4.5	2.0	12,000	1.5	11.9	9.7	8.8	4 A	4/9
	TDD 2 A (DD) ..	2.0*	0.12	135	– 1.5	1.0	26,000	1.2	2.3	7.6	2.7	5 E	9/–
	TDD 2 (DD)	2.0*	0.1	135	– 4.5	2.0	12,000	1.4	—	—	—	5 E	9/–
	904 V	4.0	0.65	200	– 2.0	1.8	34,000	2.2	—	—	—	5 A	9/6
	354 V	4.0	0.65	200	– 4.0	4.0	12,500	3.2	9.5	7.7	3.4	5 A	9/6
	244 V	4.0	0.65	200	– 5.5	5.5	9,000	2.8	—	—	—	5 A	13/6
	TDD 4 (DD)	4.0	0.65	200	– 3.5	7.0	10,300	2.9	4.3	3.1	1.7	7 G	12/6
	AT 4 (Acorn).. ..	4.0	0.2	200	– 6.0	4.5	12,500	2.0	1.0	0.6	1.4	—	50/–
	HL 13 C	13.0	0.2	200	– 4.0	4.0	12,500	3.2	6.5	8.4	3.0	7 F	9/6
	TDD 13 C	13.0	0.2	200	– 3.5	7.0	10,300	2.9	4.3	3.1	1.7	7 G	12/6
OSTAR-GANZ ..	A 520	100/250	0.024	250	– 6.0	4.0	8,800	2.5	—	—	—	5 A	—
	D 130	100/250	0.024	250	– 1.0	2.0	40,000	3.5	—	—	—	C 7 E	—
PIX	2	2.0*	0.1	150	– 4.0	1.5	20,000	1.0	—	—	—	4 A	2/6
	3	2.0*	0.1	150	– 7.5	3.4	12,000	0.9	—	—	—	4 A	2/6
	4	2.0*	0.1	150	– 1.0	1.0	37,000	0.9	—	—	—	4 A	2/6
	90 AC	4.0	1.0	200	– 1.5	3.0	23,000	1.7	—	—	—	5 A	8/6
	100 AC	4.0	1.0	200	– 6.0	5.0	7,500	2.0	—	—	—	5 A	9/6
362	H 2	2.0*	0.1	150	– 1.5	2.0	32,000	1.0	—	—	—	4 A	3/6
	HL 2	2.0*	0.1	150	– 3.0	3.0	16,000	1.5	—	—	—	4 A	3/6
	L 2	2.0*	0.1	150	– 4.5	3.0	12,000	1.2	—	—	—	4 A	3/6
	ACHL 4	4.0	1.0	250	– 4.0	4.0	10,000	3.3	—	—	—	5 A	7/6
	ACHL 4 DD (DD) ..	4.0	1.0	250	– 3.0	7.0	15,000	2.5	—	—	—	7 G	9/–
TRIOTRON ..	W 213	2.0*	0.1	150	– 2.0	1.0	24,000	1.2	—	—	5.5	4 A	3/6
	HD 2	2.0*	0.08	200	– 5.0	5.0	15,000	1.0	—	—	—	4 A	3/6
	SD 2	2.0*	0.1	200	– 5.0	7.0	12,000	1.5	—	—	—	4 A	3/6
	A 214	2.0*	0.1	150	– 4.0	4.0	10,000	1.4	—	—	5.5	4 A	3/6
	TD 2	2.0*	0.08	150	– 7.0	7.0	10,000	0.9	—	—	—	4 A	3/6
	DT 215	2.0*	0.1	135	– 4.5	2.5	10,500	1.5	—	—	—	5 E	6/6
	A 440 N	4.0	1.0	200	– 1.5	0.2	30,000	4.0	7.0	5.0	1.5	5 A	7/6
	DT 436	4.0	0.65	250	– 7.0	4.0	7,500	3.6	4.3	3.1	1.7	7 G	10/–
	DT 1336	13.0	0.2	200	– 5.0	4.0	7,500	3.6	4.3	3.1	1.7	7 G	10/–
	A 2040 N	20.0	0.18	200	– 1.5	0.2	30,000	4.0	7.0	5.0	1.5	5 A	7/6

TRIODE VALVES—(*Continued*) (AC Resistance greater than 7,000 ohms.)

Type.		Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Grid.	Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
TUNGSRAM ..	HR 210	2.0*	0.1	200	– 1.5	1.0	23,000	1.3	—	—	4.0	4 A	3/9
	LD 210	2.0*	0.1	150	– 3.0	3.0	14,000	1.3	—	—	4.0	4 A	3/9
	DDT 2 (DD)	2.0*	0.1	135	– 4.5	1.5	21,000	1.4	2.6	7.7	2.8	5 E	7/–
	HR 2	2.0*	0.05	135	– 1.5	0.6	40,000	0.6	6.5	5.5	3.5	4 A	—
	LL 2 (D)	2.0*	0.2	135	– 2.5	3.0	11,500	2.6	—	—	—	4 A	3/9
	HL 4 + ...	4.0	0.65	250	– 5.5	4.0	12,000	3.5	6.9	5.5	1.7	5 A	9/6
	HL 4 G	4.0	0.65	250	– 5.5	4.0	12,000	3.5	4.9	5.5	1.7	7 F	9/6
	DDT 4 (DD)	4.0	0.65	250	– 5.0	4.0	11,000	3.6	4.3	3.1	1.7	7 G	12/6
	DDT 6 (DD)	6.3	0.2	250	– 5.5	5.0	15,000	2.0	4.0	3.1	1.6	Ct. 8 G	15/–
	HL 13	13.0	0.2	200	– 3.0	6.0	11,000	3.5	4.9	5.5	1.7	7 F	9/6
	DDT 13 (DD) ..	13.0	0.2	200	– 5.0	4.0	11,000	3.6	4.3	3.1	1.7	7 G	12/6
AMERICAN ..	30	2.0*	0.06	135	– 9.0	3.0	10,300	0.9	3.0	2.1	6.0	A 4 A	—
	1 B 5 (DD)	2.0*	0.06	135	– 3.0	0.8	35,000	0.575	1.6	1.9	3.6	A 6 C	—
	27	2.5	1.75	250	–21.0	5.2	9,250	0.975	3.1	2.3	3.3	A 5 A	—
	55 (DD)	2.5	1.0	250	–20.0	8.0	7,500	1.1	1.5	4.3	1.5	A 6 D	—
	56	2.5	1.0	250	–13.5	5.0	9,500	1.45	3.2	2.2	3.2	A 5 A	—
	2 A 6 (DD)	2.5	0.8	250	– 2.0	0.4	91,000	1.1	1.7	3.8	1.7	A 6 D	—
	37	6.3	0.3	250	–18.0	7.5	8,400	1.1	3.5	2.9	2.0	A 5 A	—
	75 (DD)	6.3	0.3	250	– 2.0	0.4	91,000	1.1	1.7	3.8	1.7	A 6 D	—
	76	6.3	0.3	250	–13.5	5.0	9,500	1.45	3.5	2.5	2.8	A 5 A	—
	85 (DD)	6.3	0.3	250	–20.0	8.0	7,500	1.1	1.5	4.3	1.5	A 6 D	—
	6 C 5	6.3	0.3	250	– 8.0	8.0	10,000	2.0	4.0	13.0	1.8	A 8 G	—
	6 F 5	6.3	0.3	250	– 2.0	0.9	66,000	1.5	6.0	12.0	2.0	A 8 F	—
	6 Q 7 (DD)	6.3	0.3	250	– 3.0	1.1	58,000	1.2	5.0	4.4	1.4	A 8 E	—
	6 R 7 (DD)	6.3	0.3	250	– 9.0	9.5	8,500	1.9	4.8	4.0	2.5	A 8 E	—
	6 Q 6 (SD)	6.3	0.15	250	– 3.0	1.2	62,000	1.05	—	—	—	A 8 O	—
	6 L 5	6.3	0.15	250	– 9.0	8.0	9,000	1.9	3.0	5.0	2.7	A 8 G	—
	6 J 5	6.3	0.3	250	– 8.0	9.0	7,700	2.6	3.8	3.3	3.4	A 8 G	—
	6 K 5	6.3	0.3	250	– 3.0	1.1	50,000	1.4	2.4	3.6	2.0	A 8 M	—

TRIODE VALVES (AC Resistance less than 7,000 ohms.)

Type.		Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Grid.	Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
BRIMAR ..	PA 1	4.0	1.0	200	– 10.5	40.0	1,050	12.0	4,000	1,250	260	—	—	—	5 A	12/6
	16 D 1 † † ..	13.0	0.4	300	0	43.0	—	—	7,000	5,000	—	—	—	—	7 S	22/6
CLARION ..	LP 2	2.0*	0.11	150	– 9.0	8.0	5,500	1.1	12,000	75	—	—	—	—	4 A	1/9
	P 2	2.0*	0.22	150	– 8.0	10.0	6,000	2.0	7,500	200	—	—	—	—	4 A	2/6
	PX 2	2.0*	0.22	150	– 12.0	16.0	3,000	2.0	5,000	400	—	—	—	—	4 A	2/6
	ACG	4.0	1.0	200	– 7.5	8.0	6,000	2.7	12,000	200	1,000	—	—	—	5 A	3/3
	ACL	4.0	1.0	200	– 12.0	18.0	3,000	3.0	7,000	500	700	—	—	—	5 A	3/3
	ACP	4.0*	1.0	200	– 21.0	19.0	2,000	3.0	4,500	700	1,100	—	—	—	4 A	4/–
	ACPP	4.0*	2.0	400	– 25.0	50.0	1,800	5.0	4,000	5,000	500	—	—	—	4 A	6/–
	ADG	20.0	0.18	200	– 10.0	10.0	5,700	3.5	10,000	275	1,000	—	—	—	5 A	3/3
	ADL	20.0	0.18	200	– 13.0	20.0	2,750	3.0	5,000	550	650	—	—	—	5 A	3/3
COSSOR ..	215 P	2.0*	0.15	150	– 7.5	10.0	4,000	2.25	9,000	150	—	9.0	9.0	6.0	4 A	6/–
	220 P	2.0*	0.2	150	– 7.5	11.0	4,000	2.25	9,000	190	—	9.0	8.0	5.5	4 A	6/–
	220 PA	2.0*	0.2	150	– 4.5	10.0	4,000	4.0	9,000	180	—	—	—	—	4 A	6/–
	230 XP ..	2.0*	0.3	150	– 18.0	22.0	1,500	3.0	3,500	450	—	—	—	—	4 A	10/–
	41 MP	4.0	1.0	200	– 7.5	24.0	2,500	7.5	3,000	1,250	320	10.0	11.5	6.5	5 A	10/–
	41 MXP ..	4.0	1.0	200	– 12.5	40.0	1,500	7.5	2,500	2,000	300	—	—	—	5 A	12/6
	4 XP	4.0*	1.0	250	– 28.5	48.0	900	7.0	3,000	3,000	600	20.0	14.0	12.0	4 A	12/6
	680 XP ..	6.0*	0.8	400	–125.0	25.0	2,750	1.1	5,700	2,500	5,000	—	—	—	4 A	25/–
	620 T	6.0*	2.0	400	– 95.0	62.5	1,300	2.3	4,000	5,000	1,500	—	—	—	4 A	30/–
	660 T	6.0*	4.5	500	–120.0	120.0	900	2.3	2,400	11,000	1,000	—	—	—	4 A	105/–
	402 P	40.0	0.2	200	– 17.5	40.0	1,330	7.5	2,500	200	300	—	—	—	7 F	—

TRIODE VALVES—(*Continued*) (AC Resistance less than 7,000 ohms.)

Type.		Heater.		Volts.		Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Grid.							Input.	Output.	Grid-Anode.		
DARIO ..	TB 062	2.0*	0.33	150	− 10.5	13.0	3,000	2.0	8,000	550	—	—	—	—	4 A	4/6
	TB 122	2.0*	0.2	150	− 4.5	6.0	3,600	3.5	7,000	150	—	—	—	—	4 A	4/6
	TB 052	2.0*	0.15	150	− 15.0	7.0	4,200	1.2	10,000	200	—	—	—	—	4 A	4/6
	TB 032	2.0*	0.20	150	− 30.0	12.0	2,000	1.5	6,000	500	—	—	—	—	4 A	4/6
	TE 094	4.0	1.0	200	− 16.0	12.0	7,000	1.3	3,000	600	850	7.0	5.0	1.5	5 A	8/6
EVER-READY .	K 30 G	2.0*	0.2	150	− 7.0	6.0	3,600	3.5	7,000	150	—	6.3	3.3	5.5	4 A	6/-
	S 30 C	4.0*	1.0	250	− 29.0	48.0	950	6.8	2,500	2,700	600	22.7	18.7	13.95	4 A	12/6
FERRANTI ..	LP 4	4.0*	1.0	250	− 36.0	48.0	980‡	5.5‡	2,500	2,800	750	17.6	13.5	9.4	4 A	12/6
GRAHAM-FARISH	LP 2	2.0*	0.15	150	− 12.0	8.0	3,600	2.2	10,000	150	—	—	—	—	4 A	6/-
	MP 2	2.0*	0.2	150	− 12.0	12.5	2,300	3.0	5,000	250	—	—	—	—	4 A	10/-
	XP 2	2.0*	0.3	150	− 15.0	17.5	1,850	3.5	4,000	450	—	—	—	—	4 A	10/-
HIVAC	XP	2.0*	0.066	100	− 9.0	4.5	5,000	1.0	10,000	—	—	1.4	1.5	2.7	Sm. 4 A****	12/6
	P 215 ..	2.0*	0.15	150	− 12.0	8.0	3,600	2.2	10,000	150	—	—	—	—	4 A	4/9
	P 220	2.0*	0.2	150	− 7.5	6.0	4,700	3.0	9,000	175	—	—	—	—	4 A	5/6
	PP 220	2.0*	0.2	150	− 12.0	12.5	2,300	3.0	5,000	250	—	—	—	—	4 A	6/6
	PX 230 ..	2.0*	0.3	150	− 15.0	17.5	1,850	3.5	4,000	450	—	—	—	—	4 A	7/6
	PX 230 SW ..	2.0*	0.3	150	− 15.0	17.5	1,850	3.5	4,000	450	—	4.5	11.5	5.8	4 I	12/-
	AC/L	4.0	1.0	200	− 13.5	17.0	2,350	4.25	6,300	675	760	7.0	7.2	6.1	5 A	8/6
	PX 41	4.0*	1.0	250	− 40.0	48.0	830	6.0	3,500	2,500	830	—	—	—	4 A	12/6
LISSEN ..	P 220	2.0*	0.2	150	− 13.5	7.6	4,000	1.75	10,000	160	—	—	—	—	4 A	6/-
	PX 240 ..	2.0*	0.4	200	− 32.0	25.0	1,500	3.0	5,000	800	—	—	—	—	4 A	10/-
MARCONI and OSRAM	LP 2	2.0*	0.2	150	− 4.5	11.5	3,900	3.85	7,000	150	—	—	—	—	4 A	6/-
	P 2	2.0*	0.2	150	− 10.5	19.0	2,150	3.5	4,500	300	—	—	—	—	4 A	10/-
	ML 4	4.0	1.0	200	− 9.0	20.0	2,860	4.2	7,000	500	400	—	—	—	5 A	10/-
	PX 4	4.0*	1.0	250	− 34.0	48.0	830	6.0	3,200	2,500	750	—	—	—	4 A	12/6
	PX 25	4.0*	2.0	400	− 31.0	62.5	1,265	7.5	3,200	5,500	530	—	—	—	4 A	25/-
	PX 25 A ..	4.0*	2.0	400	−100.0	62.5	580	6.9	{ 4,800 / 2,800†	8,400 / 32,000† }	1,600	—	—	—	4 A	25/-
	DA 30	4.0*	2.0	500	−134.0	60.0	580	6.9	3,400†	44,000	—	—	—	—	4 A	30/-
	DA 60	6.0*	4.0	500	−135.0	120.0	835	3.0	3,000	10,000	1,150	—	—	—	Lg. 4 A	110/-
	DA 100	6.0*	2.7	1,000	−149.0	100.0	1,410	3.9	6,700	—	1,490	—	—	—	Lg. 4 A	210/-
MAZDA ..	P 220	2.0*	0.2	150	− 7.0	5.5	3,700	3.4	10,000	180	—	—	—	—	4 A	6/-
	P 220 A ..	2.0*	0.2	150	− 14.0	15.0	1,850	3.5	4,100	350	—	—	—	—	4 A	10/-
	PA 20	2.0*	2.0	250	− 27.5	50.0	1,000	6.5	2,200	2,750	550	—	—	—	4 A	12/6
	ACP	4.0	1.0	200	− 13.5	17.0	2,650	3.75	6,000	650	750	—	—	—	5 A	10/-
	ACP 1	4.0	1.0	200	− 28.0	24.0	1,450	3.7	5,000	1,000	1,200	—	—	—	5 A	12/6
	PP 3/250 ..	4.0*	1.0	250	− 28.5	50.0	1,000	6.5	2,200	2,750	565	—	—	—	4 A	12/6
	PP 5/400 ..	4.0*	2.0	400	− 32.0	62.5	1,500	6.0	2,700	5,900	510	—	—	—	4 A	25/-
	PP 3521 ..	35.0	0.2	200	− 25.0	70.0†	600	10.0	3,000†	5,700†	180†	—	—	—	7 R	12/6
MULLARD ..	PM 2	2.0*	0.2	135	− 10.5	6.0	4,400	1.7	9,000	150	—	—	—	—	4 A	6/-
	PM 2 A ..	2.0*	0.2	135	− 6.0	5.0	3,600	3.5	7,000	150	—	6.3	3.3	5.5	4 A	6/-
	PM 202 ..	2.0*	0.2	135	− 10.5	14.0	2,000	3.5	3,700	350	—	—	—	—	4 A	10/-
	104 V	4.0	1.0	200	− 12.0	17.0	3,000	4.0	6,000	550	550	—	—	—	5 A	10/-
	AC 044	4.0*	1.0	250	− 29.0	48.0	950	6.8	2,500	2,700	600	22.7	18.7	13.95	4 A	12/6
	DO 24	4.0*	2.0	400	− 34.0	63.0	1,390	6.5	4,000	5,500	540	—	—	—	4 A	25/-
	DO 26	4.0*	2.0	400	− 92.0	63.0	600	6.3	4,000	7,500	1,500	—	—	—	4 A	25/-
	DO 25	6.6*	1.1	400	−112.0	63.0	800	3.75	4,000	7,000	1,780	—	—	—	4 A	30/-
	MZ 05-60 ..	6.0*	1.65	500	− 95.0	120.0	925	3.25	1,500	10,000	790	—	—	—	Lg. 4 A	110/-
	MZ 1-75 ..	10.0*	1.1	1,000	− 80.0	75.0	2,500	4.0	8,000	20,000	1,050	—	—	—	Lg. 4 A	160/-
OSTAR-GANZ ..	U 920	100/250	0.024	200	− 7.0	7.0	3,700	3.0	10,000	750	1,000	—	—	—	5 A	—
	L 1525	100/250	0.024	200	− 20.0	20.0	1,850	3.0	5,000	900	1,000	—	—	—	5 A	—
	K 3560	100/250	0.024	200	− 50.0	60.0	500	6.0	1,200	2,500	800	—	—	—	5 A	—
	K 2050	100/250	0.024	200	− 70.0	40.0	1,000	5.0	2,700	2,500	800	—	—	—	5 A	—
PIX	20	2.0*	0.15	150	− 5.0	5.0	4,600	1.2	8,000	150	—	—	—	—	4 A	4/6
	120	2.0*	0.2	150	− 12.0	12.0	3,900	1.8	6,000	200	—	—	—	—	4 A	6/6

TRIODE VALVES—(*Continued*) (AC Resistance less than 7,000 ohms.)

Make	Type.	Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Grid.	Anode Current (mA.).	AC Resistance (ohms).	Mutual Conductance (mA/V.).	Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
362 ..	LP 2	2.0*	0.2	200	– 9.0	8.0	5,000	3.0	10,000	500	—	—	—	—	4 A	4/-
	P 2	2.0*	0.2	200	– 15.0	13.0	3,000	3.0	6,000	1,000	—	—	—	—	4 A	4/6
	ACPX 4 ..	4.0	1.0	250	– 18.0	30.0	2,000	4.0	3,000	2,500	600	—	—	—	5 A	9/-
	ACPX 4 A ..	4.0*	1.0	250	– 25.0	50.0	1,200	5.0	2,500	3,000	500	—	—	—	4 A	9/-
	PX 25	4.0*	2.0	400	– 50.0	65.0	1,000	6.0	3,000	7,000	800	—	—	—	4 A	20/-
	PX 50	6.0*	2.0	500	– 70.0	100.0	800	5.0	7,500	13,000	790	—	—	—	Lg. 4 A	50/-
	PX 100 ..	6.0*	3.0	1,000	–140.0	100.0	1,200	5.0	7,000	35,000	1,400	—	—	—	Lg. 4 A	100/-
TRIOTRON ..	YD 02	2.0*	0.22	150	– 7.5	12.0	4,500	2.0	10,000	350	—	—	—	—	4 A	4/6
	ZD 2	2.0*	0.15	150	– 15.0	10.0	5,000	1.0	13,000	150	—	—	—	—	4 A	4/6
	UD 2	2.0*	0.22	150	– 15.0	15.0	2,700	2.0	5,000	500	—	—	—	—	4 A	4/6
	E 235	2.0*	0.33	200	– 12.0	18.0	3,800	3.0	8,000	550	—	—	—	—	4 A	4/6
	E 430 N ..	4.0	1.0	200	– 15.0	15.0	3,000	3.0	10,000	350	1,000	7.0	5.0	1.5	5 A	7/6
	K 435/10 ..	4.0*	0.65	250	– 40.0	40.0	1,000	3.5	1,500	2,500	1,000	5.0	6.0	7.0	4 A	10/-
	K 480	4.0*	2.0	550	– 36.0	45.0	1,250	8.0	3,500	5,000	800	7.1	4.4	6.0	4 A	20/-
	K 450/50 ..	4.0*	3.0	400	– 50.0	120.0	1,250	5.0	1,500	12,000	500	—	—	—	4 A	40/-
TUNGSRAM ..	P 215	2.0*	0.15	150	– 9.0	10.0	3,300	1.5	7,000	260	—	—	—	—	4 A	4/9
	SP 220	2.0*	0.2	150	– 15.0	15.0	2,200	3.0	6,700	360	—	—	—	—	4 A	4/9
	LP 220	2.0*	0.2	150	– 4.5	5.0	3,900	3.5	7,500	200	—	—	—	—	4 A	4/9
	P 12/250 ..	4.0*	1.0	250	– 33.0	48.0	850	6.0	2,400	2,750	700	—	—	—	4 A	12/6
	P 15/250 ..	4.0*	1.0	250	– 44.0	60.0	660	6.0	2,500	4,200	750	—	—	—	4 A	12/6
	O 15/400 ..	4.0*	1.0	400	– 37.0	40.0	1,600	5.0	6,000	3,500	900	—	—	—	4 A	12/6
	P 25/500 ..	6.0*	1.1	500	–150.0	53.0	800	3.75	8,000	8,000	2,850	—	—	—	4 A	20/-
	P 26/500 ..	4.0*	2.0	400	–100.0	62.5	580	6.8	4,500	7,200	1,600	—	—	—	4 A	20/-
	P 27/500 ..	4.0*	2.0	400	– 32.0	62.5	1,300	7.2	3,500	5,800	550	—	—	—	4 A	20/-
	P 60/500 ..	6.0*	4.0	600	–110.0	130.0	1,000	3.5	2,600	15,000	1,000	—	—	—	Lg. 4 A	88/-
	P –100/1,000 ..	6.0*	2.7	1,000	–145.0	100.0	1,400	3.9	6,700	30,000	1,500	—	—	—	Lg. 4 A	168/-
AMERICAN ..	31	2.0*	0.13	135	– 22.5	8.0	4,100	0.925	7,000	185	—	3.5	2.7	5.7	A 4 A	—
	45	2.5	1.5	275	– 56.0	36.0	1,700	2.05	4,600	2,000	1,550	4.0	3.0	7.0	A 4 A	—
	2 A 3	2.5	2.5	250	– 45.0	60.0	800	5.25	2,500	3,500	750	9.0	4.0	13.0	A 4 A	—
	2 B 6 (DT) ..	2.5	2.25	250	– 24.0	40.0	5,150	3.5	5,000	4,000	600	—	—	—	A 7 D	—
	6 D 5	6.3	0.7	275	– 40.0	31.0	2,250	2.1	7,200	1,400	1,300	—	—	—	A 8 F	—
	6 B 5†† ..	6.3	0.8	300	0	45.0	—	—	7,000	4,000	—	—	—	—	A 6 E	—

OUTPUT TETRODES AND PENTODE VALVES

Make	Type.	Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Screen.	Volts. Grid.	Current (mA.). Anode.	Current (mA.). Screen.	Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
BRIMAR ..	Pen B 1	2.0*	0.2	150	150	– 4.5	8.1	1.8	18,000	500	—	—	—	—	5 F	11/-
	Pen A 1	4.0*	1.0	250	250	–16.0	32.0	7.0	8,000	2,850	450	—	—	—	5 G	13/6
	7 A 2	4.0	1.2	250	250	–17.0	32.0	8.0	8,000	3,200	330	—	—	—	7 J	13/6
	7 A 3	4.0	2.0	250	250	– 6.0	32.0	8.0	8,500	4,000	140	—	—	—	7 J	13/6
	7 D 8	13.0	0.2	250	250	– 6.0	32.0	8.0	8,500	4,000	140	—	—	—	7 J	13/6
	7 D 6	40.0	0.2	250	250	– 6.0	32.0	8.0	8,500	4,000	140	—	—	—	7 J	13/6
	7 D 3	40.0	0.2	150	150	–22.5	40.0	10.0	3,750	2,500	450	—	—	—	7 J	13/6
CLARION ..	PN 2	2.0*	0.22	150	150	– 7.5	6.0	0.75	18,000	500	—	—	—	—	5 F	3/9
	ACPN	4.0	1.0	250	200	–12.0	22.0	8.0	9,000	2,000	400	—	—	—	5 G	4/6
	ACPNDH	4.0*	1.0	250	200	–10.0	18.0	7.0	8,000	1,900	400	—	—	—	5 F	4/6
	ADPN	20.0	0.18	250	200	–15.0	22.0	8.0	9,000	2,200	500	—	—	—	5 G	4/6

OUTPUT TETRODES AND PENTODE VALVES—(*Continued*)

Make	Type	Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Screen.	Volts. Grid.	Current (mA.). Anode.	Current (mA.). Screen.	Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
COSSOR	230 PT	2.0*	0.3	150	150	−15.0	14.0	3.0	10,000	1,000	—	—	—	—	5 F	16/6
	220 PT	2.0*	0.2	150	150	− 9.0	19.0	4.0	7,500	1,000	—	—	—	—	5 F	13/6
	220 HPT	2.0*	0.2	150	150	− 4.5	8.0	1.5	17,000	500	—	10.5	11.0	—	5 F	11/-
	MP Pen	4.0	1.0	250	250	−16.0	30.0	6.0	10,000	3,500	450	14.0	12.0	—	7 J	13/6
	42 MP Pen	4.0	2.0	250	250	− 5.5	32.0	6.0	8,000	3,100	140	15.5	12.0	1.2	7 J	13/6
	PT 41	4.0*	1.0	250	200	−12.5	30.0	6.0	8,000	2,600	350	—	—	—	5 F	13/6
	PT 41 B	4.0*	1.0	400	300	−40.0	30.0	6.0	8,000	3,600	1,200	—	—	—	5 F	22/6
	40 PPA	40.0	0.2	150	150	−25.0	36.0	6.0	4,000	2,300	570	—	—	—	7 J	13/6
	402 Pen	40.0	0.2	250	250	− 6.7	40.0	—	5,500	—	—	—	—	—	7 J	12/6
DARIO	TC 432	2.0*	0.2	150	150	− 4.5	9.5	2.0	15,000	420	—	—	—	—	4 G & 5 F	10/-
	TE 434	4.0*	1.1	250	250	−14.0	36.0	7.0	8,000	3,400	325	9.0	14.0	1.1	5 F	12/6
	TE 534	4.0	1.1	250	250	−15.0	24.0	7.0	10,000	2,500	500	7.0	7.0	1.2	5 G & 7 O	12/6
	TE 634	4.0	1.35	250	250	−22.0	36.0	9.0	8,000	3,400	500	8.0	9.0	1.0	7 O	12/6
	TL 44	4.0	1.5	200	200	− 6.0	32.0	3.0	8,000	3,500	175	—	—	—	7 O	12/6
	TB 4320	20.2	0.2	200	100	−19.0	40.0	5.0	7,000	3,500	400	—	—	1.1	Ct. 8 D	12/6
	TL 413	33.0	0.2	250	250	−13.0	36.0	4.5	4,500	4,000	320	—	—	1.2	7 O	12/6
EVER-READY ..	K 70 B	2.0*	0.4	150	150	− 4.5	9.5	2.5	15,000	425	—	10.2	10.7	1.0	5 F	11/-
	K 70 D	2.0*	0.3	135	135	− 2.4	5.0	0.8	24,000	300	—	11.0	11.0	1.15	5 F	11/-
	A 70 C..	4.0	1.95	250	250	− 5.8	32.0	—	8,000	3,800	145	11.5	8.7	1.0	7 J	13/6
	A 70 B	4.0	1.5	250	250	−22.0	32.0	—	8,000	3,400	500	—	—	—	7 J	13/6
	A 70 D	4.0	1.95	250	250	− 5.8	32.0	—	8,000	3,800	145	11.5	8.7	1.0	7 J	13/6
	C 70 D	35.0	0.2	200	200	− 9.0	40.0	—	4,000	3,100	165	14.9	10.7	1.2	7 J	13/6
FERRANTI ..	PT 4 D (DD) ..	4.0	2.0	250	250	− 6.0	32.5	7.0	6,500	3,500	150	12.0	18.0	0.7	7 I	16/-
	PTA	13.0	0.3	250	250	− 9.8	32.5	5.0	7,000	3,200	250	12.0	10.0	0.6	7 J	13/6
	PTSA	26.0	0.3	200	200	− 5.5	40.0	7.0	6,000	3,500	120	13.5	19.0	0.8	7 Q	13/6
	PTZ	40.0	0.2	200	200	− 5.5	40.0	7.0	6,000	3,500	120	13.5	19.0	0.8	7 Q	13/6
GRAHAM-FARISH	PT 2	2.0*	0.2	150	150	− 4.5	10.0	1.8	12,000	500	—	6.3	3.8	0.9	5 F	11/-
	PP 2	2.0*	0.2	150	150	− 9.0	18.0	4.0	7,600	750	—	6.1	3.8	0.8	5 F	11/-
	AC/PT..	4.0	1.0	250	250	−10.0	32.0	4.3	7,500	3,400	230	7.9	4.8	1.6	7 J	16/6
	AC/PP..	4.0	2.0	250	250	− 5.5	32.0	4.3	6,600	3,200	150	10.2	5.0	1.5	7 J	18/6
HIVAC	XY	2.0*	0.14	100	100	− 6.0	5.5	1.1	15,000	—	—	—	—	—	Sm. 5 A	15/6
	Y 220 (T)	2.0*	0.2	150	150	− 4.5	10.5	1.3	11,500	500	—	6.3	3.8	0.9	4 G or 5 J	9/6
	Z 220 (T)	2.0*	0.2	150	150	− 6.0	18.0	2.1	7,500	1,000	—	6.1	3.8	0.8	4 G or 5 J	9/6
	AC/Y (T)	4.0	1.0	250	250	−10.0	32.0	4.3	6,500	3,000	300	7.9	4.8	1.6	5 G or 7 J	11/6
	AC/YY (T)	4.0	2.0	250	250	−10.0	68.0	10.0	3,000	5,000	140	9.5	6.0	1.9	7 J	25/-
	AC/Z (T)	4.0	2.0	250	250	− 5.5	32.0	4.3	6,500	3,000	160	10.2	5.0	1.5	5 G or 7 J	11/6
	AC/ZDD (T) (DD) ..	4.0	2.0	250	250	− 5.5	32.0	4.3	6,500	3,000	160	9.9	4.3	0.8	7 I	14/-
	FY	4.0*	1.0	250	250	−10.0	32.0	6.0	6,000	3,000	250	7.6	4.8	1.6	5 J	11/6
	Y 13	13.0	0.3	250	250	−22.0	35.0	4.5	4,000	3,000	550	7.6	4.8	1.5	7 J	11/6
	Z 26	26.0	0.3	250	250	−11.0	38.0	6.0	4,000	3,000	250	9.8	4.9	1.5	7 J	11/6
LISSEN	PT 225	2.0*	0.2	150	150	− 6.0	8.0	2.0	18,700	400	—	—	—	—	4 G or 5 F	11/-
	PT 2 A	2.0*	0.2	150	150	−10.5	18.0	3.0	8,500	1,100	—	—	—	—	4 G or 5 F	11/-
	ACPT	4.0	1.25	250	200	− 8.0	31.0	4.0	7,500	3,000	240	—	—	—	7 J	13/6
MARCONI and OSRAM	PT 2	2.0*	0.2	150	150	− 4.5	9.5	1.9	20,000	500	—	—	—	—	5 F	11/-
	MPT 4..	4.0	1.0	250	200	−11.0	32.0	5.0	8,000	2,200	300	—	—	—	7 J	13/6
	N 41	4.0	2.0	250	250	− 3.5	32.0	8.0	7,800	3,500	90	19.5	12.5	2.0	7 J	13/6
	N 42	4.0	1.0	250	250	−16.5	34.0	5.5	7,000	—	420	—	—	—	7 J	13/6
	N 43	4.0	2.0	250	250	− 4.4	40.0	10.0	5,400	—	90	15.5	16.5	0.3	7 Q	25/-
	DN 41 (DD) ..	4.0	2.3	250	250	− 3.5	32.0	8.0	7,800	3,500	90	18.5	15.7	0.75	7 I	16/-
	PT 25	4.0*	2.0	400	200	−22.0	62.5	10.6	6,000	10,000	330	—	—	—	5 F	45/-
	PT 25 H	4.0*	2.0	400	400	−16.0	62.5	12.5	5,000	10,000	250	—	—	—	5 F	45/-
	N 30 and N 30 G ..	13.0	0.3	250	250	−15.0	32.0	8.0	7,500	3,200	375	—	—	—	7 J	13/6
	N 31	{13.0 / 26.0}	{0.6 / 0.3}	200	180	− 4.4	40.0	10.6	5,500	2,500	87	19.0	11.0	0.7	7 T	13/6

OUTPUT TETRODES AND PENTODE VALVES—(*Continued*)

Make	Type.	Heater. Volts.	Heater. Amps.	Volts. Anode.	Volts. Screen.	Volts. Grid.	Current (mA.). Anode.	Current (mA.). Screen.	Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.). Input.	Capacities (mmfds.). Output.	Capacities (mmfds.). Grid-Anode.	Base.	Price.
MAZDA ..	Pen 220	2.0*	0.2	150	150	– 4.5	9.0	1.6	14,000	600	—	—	—	—	5 F	11/–
	Pen 220 A	2.0*	0.2	150	150	– 9.0	18.0	3.0	6,000	1,100	—	—	—	—	5 F	13/6
	Pen 231	2.0*	0.3	120	120	– 2.5	5.0	1.0	19,000	370	—	—	—	—	5 F	13/6
	AC/Pen	4.0	1.0	250	250	–15.5	32.0	5.0	7,500	3,400	400	—	—	—	7 J	13/6
	AC 2/Pen	4.0	1.75	250	250	– 5.3	32.0	6.0	6,700	3,500	140	—	—	—	7 J	13/6
	AC 2/Pen DD (DD)	4.0	2.0	250	250	– 5.3	32.0	6.0	6,700	3,500	140	—	—	—	7 I	16/–
	Pen 1340	13.0	0.4	240	240	– 8.6	41.0	8.0	5,500	4,000	175	—	—	—	7 J	13/6
	Pen DD 1360 (DD)	13.0	0.6	250	250	– 5.3	32.0	6.0	6,700	3,500	140	—	—	—	7 I	16/–
	Pen 3520	35.0	0.2	250	250	–10.0	53.0	9.0	4,400	4,600	165	—	—	—	7 J	13/6
	Pen DD 4020 (DD)	40.0	0.2	250	250	– 8.0	41.0	8.2	5,000	4,100	165	—	—	—	7 I	16/–
MULLARD ..	PM 22 A	2.0*	0.14	135	135	– 4.5	6.0	1.4	15,000	425	—	10.2	10.7	1.0	5 F	11/–
	PM 22	2.0*	0.3	135	135	– 9.0	13.0	3.5	8,000	600	—	—	—	—	5 F	16/6
	PM 22 C	2.0*	0.3	135	135	–16.0	23.0	—	5,000	1,450	—	—	—	—	5 F	13/6
	PM 22 D	2.0*	0.3	135	135	– 2.4	5.0	0.8	24,000	300	—	11.0	11.0	1.15	5 F	13/6
	Pen 4 VA	4.0	1.5	250	250	–22.0	32.0	—	8,000	3,400	500	—	—	—	7 J	13/6
	Pen A 4	4.0	1.95	250	250	– 5.8	32.0	—	8,000	3,800	145	11.5	8.7	1.0	7 J	13/6
	PM 24 M	4.0*	1.0	250	250	–18.0	30.0	7.0	8,000	3,000	500	—	—	—	5 F	13/6
	PM 24 D	4.0*	2.0	500	200	–35.0	50.0	9.0	7,000	10,000	750	—	—	—	5 F	45/–
	Pen 26	24.0	0.2	200	100	–19.0	40.0	—	9,000	3,500	420	—	—	—	Ct. 8 D	18/6
	Pen 36 C	35.0	0.2	200	200	– 9.0	40.0	—	4,000	3,100	165	14.9	10.7	1.2	7 J	13/6
OSTAR-GANZ ..	PT 3	100/250	0.024	250	250	–16.0	25.0	5.0	7,000	2,000	500	—	—	—	C 7 F	—
	M 43	100/250	0.037	250	200	–26.0	40.0	4.0	5,000	3,500	500	—	—	—	C 7 F	—
	M 44	100/250	0.037	250	200	– 7.5	40.0	5.0	5,000	3,000	160	—	—	—	C 7 F	—
362 ..	ME 2	2.0*	0.2	200	200	–12.0	13.0	4.0	7,000	1,000	—	—	—	—	5 F	10/–
	ME 2 A	2.0*	0.2	200	200	–12.0	13.0	4.0	7,000	1,000	—	—	—	—	4 G	10/–
	ACME 4	4.0	1.0	250	250	–16.0	26.0	12.0	5,000	3,000	400	—	—	—	5 G	10/6
	ACME 4 B	4.0*	1.0	250	250	–22.0	42.0	12.0	3,000	3,500	500	—	—	—	5 F	10/6
	ACME 4 C	4.0	2.0	250	250	–16.0	49.0	19.0	3,000	3,500	300	—	—	—	7 J	13/–
	ME 25	4.0*	2.0	400	400	–40.0	60.0	19.0	6,000	9,000	700	—	—	—	5 F	30/–
TRIOTRON ..	P 225	2.0*	0.2	150	150	– 4.5	8.0	2.0	15,000	500	—	—	—	—	4 G & 5 F	8/6
	P 215	2.0*	0.25	150	150	–15.0	15.0	2.0	10,000	500	—	—	—	—	4 G & 5 F	8/6
	P 435	4.0*	1.1	250	250	–15.0	45.0	5.0	7,000	2,800	400	9.0	14.0	1.1	5 F	11/–
	P 440	4.0*	2.0	550	200	–40.0	45.0	10.0	7,000	7,000	730	15.0	12.0	3.0	5 F	30/–
	P 440 N	4.0	1.1	250	250	–15.0	24.0	5.0	7,500	2,000	500	7.0	7.0	1.2	5 G & 7 O	11/–
	P 441 N	4.0	1.35	250	250	–22.0	36.0	3.2	9,000	2,800	540	8.0	9.0	1.0	7 O	11/–
	P 495	4.0	1.5	250	250	– 6.0	32.0	3.0	8,000	3,500	175	—	—	—	7 O	11/–
	P 2460	24.0	0.18	200	100	–19.0	40.0	5.0	7,500	3,500	400	—	—	1.2	5 G	11/–
	P 2060	24.0	0.2	200	100	–19.0	40.0	5.0	7,000	3,500	400	—	—	1.1	Ct. 8 D	11/–
	P 3580	35.0	0.2	250	250	–13.0	36.0	4.5	4,500	4,000	320	—	—	1.2	7 O	11/–
TUNGSRAM .	PP 222	2.0*	0.22	150	150	– 6.0	6.0	2.0	14,000	600	—	—	—	—	5 F	10/–
	PP 225	2.0*	0.265	135	135	–12.0	18.0	2.0	6,000	900	—	—	—	—	5 F	11/–
	PP 2	2.0*	0.14	135	135	– 5.0	7.0	1.0	19,000	440	—	—	—	—	—	—
	PP 4	4.0*	1.1	250	250	–15.0	36.0	6.0	7,500	2,800	400	—	—	—	5 F	13/6
	APP 4 A	4.0	1.2	250	250	–16.5	36.0	6.0	7,000	3,500	400	—	—	—	7 J	13/6
	APP 4 B	4.0	2.0	250	250	– 5.0	36.0	4.0	6,500	3,400	150	—	—	—	7 J	13/6
	APP 4 C	4.0	2.0	250	250	– 5.0	36.0	4.0	7,000	3,600	150	—	—	—	7 O	13/6
	APP 4 D	4.0	2.0	250	250	–16.0	72.0	7.0	3,500	7,500	145	—	—	—	7 O	16/6
	APP 4 G	4.0	2.0	250	250	– 5.0	36.0	4.0	7,000	3,600	150	—	—	—	7 E	—
	PP 35	35.0	0.2	200	200	– 6.5	45.0	5.0	4,400	3,200	170	—	—	—	7 J	13/6
	PP 36	35.0	0.2	200	200	– 6.5	45.0	5.0	5,000	3,200	170	—	—	—	7 O	13/6
AMERICAN ..	33	2.0*	0.26	135	135	–13.5	14.5	3.0	7,000	700	—	8.0	12.0	1.0	A 5 C	—
	1 F 4	2.0*	0.12	135	135	– 4.5	8.0	2.6	16,000	340	—	—	—	—	A 5 C	—
	47	2.5	1.75	250	250	–16.5	31.0	6.0	7,000	2,700	450	8.6	13.0	1.2	A 5 C	—
	59	2.5	2.0	250	250	–18.0	35.0	9.0	6,000	3,000	400	—	—	—	A 7 F	—
	2 A 5	2.5	1.75	250	250	–16.5	34.0	6.5	7,000	3,000	400	—	—	—	A 6 H	—
	38	6.3	0.3	250	250	–25.0	22.0	3.8	10,000	2,500	1,000	3.5	7.5	0.3	A 5 E	—
	41	6.3	0.4	250	250	–18.0	32.0	5.5	7,600	3,400	475	—	—	—	A 6 H	—
	42	6.3	0.7	250	250	–16.5	34.0	6.5	7,000	3,000	400	—	—	—	A 6 H	—
	89	6.3	0.4	250	250	–25.0	32.0	5.5	6,750	3,400	650	—	—	—	A 6 I	—

OUTPUT TETRODES AND PENTODE VALVES—(*Continued*)

	Type.	Heater.		Volts.			Current (mA.).		Optimum Load (ohms).	Power Output (mW.).	Bias Resistance (ohms).	Capacities (mmfds.).			Base.	Price.
		Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.				Input.	Output.	Grid-Anode.		
AMERICAN—contd.	6 A 4 and LA ..	6.3*	0.3	180	180	−12.0	22.0	3.9	8,000	1,400	465	—	—	—	A 5 C	—
	6 F 6	6.3	0.7	315	315	−22.0	42.0	8.0	7,000	5,000	440	—	—	—	A 8 H	—
	6 L 6 (T) ..	6.3	0.9	375	250	− 9.0	24.0	0.6	14,000	4,200	360	—	—	—	—	—
	12 A 5	12.6	0.3	180	180	−27.0	40.0	9.0	4,500	2,800	550	—	—	—	A 7 G	—
	43	25.0	0.3	135	135	−20.0	34.0	7.0	4,000	2,000	500	—	—	—	A 6 H	—
	25 A 6	25.0	0.3	180	135	−20.0	40.0	8.0	5,000	2,750	400	—	—	—	A 8 H	—
	25 B 6	25.0	0.3	95	95	−15.0	45.0	4.0	2,000	1,750	300	—	—	—	A 8 H	—
	48	30.0	0.4	125	100	−20.0	56.0	9.5	1,500	2,500	300	—	—	—	A 6 H	—

QUIESCENT OUTPUT VALVES

	Type.	Heater.		Volts.			Current (mA.).			Input Impedance (ohms).	Optimum Load (ohms).	Power Output (mW.).	Base.	Price.
							No-signal		Average.					
		Volts.	Amps.	Anode.	Screen.	Grid.	Anode.	Screen.						
CLARION ..	B 22 (B)	2.0*	0.22	150	—	0	1.3	—	5.0	9,000	13,000	1,200	7 K	4/6
	B 24 (B)	2.0*	0.44	150	—	0	1.8	—	7.0	7,200	9,000	2,000	7 K	5/6
COSSOR	220 B (B)	2.0*	0.2	120	—	0	2.5	—	6.0	3,000	12,000	1,100	7 K	11/-
	240 B (B)	2.0*	0.4	120	—	0	3.0	—	8.5	2,500	8,000	2,000	7 K	11/-
DARIO	TB 402 (B)	2.0*	0.2	150	—	0	3.0	—	6.0	4,000	14,500	1,500	7 K	9/6
EVER-READY ..	K 77 A (Q)	2.0*	0.45	150	150	−13.5	4.0	—	—	∞	16,000	1,400	9 D	17/6
	K 33 A (B)	2.0*	0.2	150	—	0	3.0	—	—	3,000	14,000	1,250	7 K	11/-
	K 33 B (B)	2.0*	0.2	150	—	− 4.5	3.0	—	—	3,000	14,000	1,250	7 K	11/-
GRAHAM-FARISH	QP 2 (Q)	2.0*	0.4	150	150	18.0	8.0	1.2	12.0	∞	14,500	1,400	7 L	19/6
HIVAC	B 230 (B)	2.0*	0.3	150	—	0	2.5	—	5.5	4,000	14,500	1,250	7 K	9/6
	DB 240 (B) .. .. }	2.0*	0.4	{150	—	0	2.5	—	5.5	4,000	14,500	1,250 }	7 P	15/6
	(B + D) (D) .. .. }			{120	—	− 4.5	3.0	—	3.0	∞	—	— }		
	QP 240 (Q)	2.0*	0.4	150	150	−18.0	8.0	1.2	14.0	∞	14,500	1,400	7 L	17/6
LISSEN	BB 240 A (B)	2.0*	0.4	150	—	− 3.0	5.0	—	7.0	8,000	8,000	3,500	7 K	11/-
MARCONI and OSRAM	B 21 (B)	2.0*	0.2	150	—	− 6.0	2.2	—	7.5	36,000	12,000	2,000	7 K	11/-
	QP 21 (Q)	2.0*	0.4	150	150	− 9.0	3.0	—	6.0	∞	24,000	1,200	7 L	17/6
MAZDA	PD 220 (B)	2.0*	0.2	150	—	− 1.15	0.8	—	7.0	3,300	11,500	2,850	7 K	11/-
	PD 220 A (B)	2.0*	0.2	150	—	− 6.0	2.5	—	7.5	7,400	10,000	2,900	7 K	11/-
	QP 240 (Q)	2.0*	0.4	150	130	−11.5	4.0	0.9	6.0	∞	15,000	2,250	9 D	17/6
	QP 230 (Q)	2.0*	0.3	110	110	− 8.6	4.25	1.05	—	∞	17,000	700	7 L	17/6
MULLARD ..	PM 2 B (B)	2.0*	0.2	135	—	0	3.0	—	4.2	4,000	14,000	1,450	7 K	11/-
	PM 2 BA (B)	2.0*	0.2	135	—	− 4.5	3.0	—	3.8	4,000	14,000	1,450	7 K	11/-
	QP 22 A (Q)	2.0*	0.45	135	135	−12.0	2.5	—	4.0	∞	16,000	2,000	9 D	17/6
362	BA 2 (B)	2.0*	0.2	150	—	0	1.5	—	6.0	10,000	10,000	1,500	7 K	9/-
	BX 2 (B)	2.0*	0.4	180	—	0	2.5	—	10.0	6,000	7,000	3,000	7 K	9/-
TRIOTRON ..	E 220 B (B)	2.0*	0.3	150	—	0	3.0	—	7.0	6,500	18,000	1,350	7 K	9/6
TUNGSRAM ..	CB 220 (B)	2.0*	0.2	150	—	0	2.5	—	17.0	4,000	10,000	2,000	7 K	11/-
	CB 215 (B)	2.0*	0.22	135	—	0	2.0	—	15.0	—	10,000	1,700	7 K	11/-
AMERICAN ..	19 (B)	2.0*	0.26	135	—	0	5.0	—	—	—	10,000	2,100	A 6 G	—
	49 (B) (T)	2.0*	0.12	180	—	0	4.0†	—	—	—	12,000†	3,500†	A 5 D	—
	53 (B)	2.5	2.0	300	—	0	35.0	—	—	—	10,000	10,000	A 7 E	—
	46 (B) (T)	2.5*	1.75	400	—	0	12.0†	—	—	—	5,800†	20,000†	A 5 D	—
	79 (B)	6.3	0.6	250	—	0	10.6	—	—	—	14,000	8,000	A 6 F	—
	6 A 6 / 6 N 7 (B)	6.3	0.8	300	—	0	35.0	—	—	—	10,000	10,000	A 7 E / A 8 N	—

RECTIFYING VALVES

Make	Type.	Filament Volts.	Filament Amps.	Type of Rectification.	Max. Anode Volts (RMS).	Max. Rect. Current (mA.).	Unsmoothed Rect. Volts at Full-current.	Unsmoothed Rect. Volts at Half-current.	Base.	Price.
BRIMAR	R 1	4.0	1.0	FW	250—0—250	60	260	290	4 E	10/6
	R 2	4.0	2.5	FW	350—0—350	120	360	410	4 E	10/6
	R 3	4.0	2.5	FW	500—0—500	120	610	640	4 E	15/-
	1 A 7	4.0	2.5	FW	350—0—350	120	360	410	4 E	10/6
	1 D 5	40.0	0.2	HW	250	75	265	300	5 I	10/6
CLARION	UF 4	4.0*	1.0	FW	250—0—250	60	240	275	4 E	3/6
	UH 4	4.0*	1.0	HW	250	40	235	285	4 D	3/6
	UF 41	4.0	2.0	FW	350—0—350	100	330	370	4 E	4/6
	UDH	20.0	0.18	HW	250	60	250	270	5 I	5/6
COSSOR	506 BU	4.0*	1.0	FW	250—0—250	60	230	270	4 E	10/6
	442 BU	4.0*	2.5	FW	350—0—350	120	250	400	4 E	10/6
	460 BU	4.0*	2.5	FW	500—0—500	120	520	600	4 E	15/-
	40 SUA	40.0	0.2	HW	250	75	210	280	5 I	10/6
DARIO	SW 1	4.0*	1.0	HW	400	60	400	450	4 D	6/6
	FW 1	4.0*	1.0	FW	250—0—250	60	245	280	4 E	7/6
	FW 2	4.0*	1.0	FW	350—0—350	120	320	370	4 E	9/6
	FW 3	4.0*	2.0	FW	500—0—500	120	500	570	4 E	10/6
	1 FW 1	4.0	2.0	FW	500—0—500	120	500	570	4 E	10/6
	TW 1	20.0	0.2	HW	250	80	250	270	5 I	9/6
	TW 2	30.0	0.2	FW	125—0—125	120	125	150	5 H	10/6
EVER-READY	A 11 B	4.0	2.4	FW	350—0—350	120	395	418	4 E	10/6
	S 11 A	4.0	21.0	FW	250—0—250	60	250	275	4 E	10/6
	A 11 C	4.0	2.4	FW	500—0—500	120	550	600	4 E	15/-
	A 11 D	4.0	2.0	FW	350—0—350	120	380	430	4 E	10/6
	C 10 B	20.0	0.2	HW	250	75	210	265	5 I	10/6
FERRANTI	R 4	4.0*	2.5	FW	350—0—350	120	275	350	4 E	10/6
	R 4 A	4.0*	2.5	FW	500—0—500	120	475	550	4 E	15/-
	RA	13.0	0.3	FW	250—0—250	50	290	325	5 H	10/6
	RS	13.0	0.3	HW	250	75	230	290	5 I	10/6
	RZ	20.0	0.2	HW	250	75	230	290	5 I	10/6
GRAHAM-FARISH	UU 60/250	4.0	1.25	FW	300—0—300	75	310	355	4 E	12/6
	UU 120/350	4.0	2.5	FW	350—0—350	120	325	380	4 E	15/-
HIVAC	UU 60/250	4.0	1.25	FW	300—0—300	75	310	360	4 E	8/6
	UU 120/350	4.0	2.5	FW	350—0—350	120	345	395	4 E	10/6
	UU 120/500	4.0	2.5	FW	500—0—500	120	530	595	4 E	12/6
	MR 1	4.0*	3.0	HW	1,000	250	1,100	1,220	4 D	20/-
	U 36	13.0 or 26.0	0.6 or 0.3	HW FW VD	250 250—0—250 110	75 120 75	175 230 140	240 270 205	7 M	12/6
LISSEN	UU 41	4.0*	1.0	FW	300—0—300	80	330	360	4 E	10/6
MARCONI and OSRAM	U 10	4.0*	1.0	FW	250—0—250	60	260	300	4 E	10/6
	U 12	4.0*	2.5	FW	350—0—350	120	325	380	4 E	10/6
	MU 12	4.0	2.5	FW	350—0—350	120	340	410	4 E	10/6
	U 14	4.0*	2.5	FW	500—0—500	120	540	620	4 E	15/-
	MU 14	4.0	2.5	FW	500—0—500	120	540	600	4 E	15/-
	U 18	4.0*	3.75	FW	500—0—500	250	520	600	4 E	25/-
	U 16	2.0*	0.25	HW	5,000	2	6,800	7,000	4 F	20/-
	U 17	4.0*	1.0	HW	2,500	30	2,950	3,050	4 F	20/-
	GU 1	4.0*	3.0	HW, MV	1,000	250	1,100	1,150	4 D	25/-
	GU 5	4.0*	3.0	HW, MV	1,500	250	1,270	1,300	4 F	25/-
	U 30	26.0	0.3	HW VD	180 220	120 75	136 425	175 480	7 M	15/-
MAZDA	UU 3	4.0	2.2	FW	250—0—250	60	275	305	4 E	10/6
	UU 4	4.0	2.2	FW	350—0—350	120	370	415	4 E	10/6
	UU 5	4.0	2.3	FW	500—0—500	120	555	600	4 E	15/-
	U 4020	40.0	0.2	HW	250	75	260	300	5 I	10/6
	MU 2	2.0*	2.4	HW, MV	4,000	5	—	—	4 F	20/-

RECTIFYING VALVES—(*Continued*)

Type.		Filament. Volts.	Filament. Amps.	Type of Rectification.	Max. Anode Volts (RMS).	Max. Rect. Current (mA.).	Unsmoothed Rect. Volts at Full-Current.	Unsmoothed Rect. Volts at Half-Current.	Base.	Price.
MULLARD	1 W 2	4.0	1.2	FW	250—0—250	60	220	260	4 E	10/6
	DW 2	4.0*	1.0	FW	250—0—250	60	250	275	4 E	10/6
	1 W 3	4.0	2.4	FW	350—0—350	120	395	418	4 E	10/6
	DW 3	4.0*	2.0	FW	350—0—350	120	350	375	4 E	10/6
	1 W 4	4.0	2.4	FW	500—0—500	120	550	600	4 E	15/-
	1 W 4/350	4.0	2.0	FW	350—0—350	120	380	430	4 E	10/6
	DW 4	4.0*	2.0	FW	500—0—500	120	500	575	4 E	15/-
	RZ 1-150	4.0*	4.0	FW	1,000—0—1,000	150	1,100	1,200	4 E	60/-
	HVR 1	2.0*	0.3	HW	6,000	5	5,400	6,900	4 F	20/-
	UR 1 C	20.0	0.2	HW	250	75	210	265	5 I	10/6
	UR 3	30.0	0.2	FW	250—0—250	120	270	310	Ct. 8 F	15/-
OSTAR-GANZ	EG 50	100/250	0.024	HW	300	50	250	300	5 I	—
	EG 100	100/250	0.024	HW	300	120	200	300	5 I	—
	NG 100	100/250	0.044	2×HW	300	2×100	200	300	C 7 G	—
PHILIPS	1821	4.0*	1.0	FW	250—0—250	60	250	280	4 E	10/6
	1881	4.0	1.2	FW	250—0—250	60	250	285	4 E	10/6
	1807	4.0*	2.0	FW	350—0—350	120	350	390	4 E	10/6
	1867	4.0	2.4	FW	350—0—350	120	350	395	4 E	10/6
	1561	4.0*	2.0	FW	500—0—500	120	500	585	4 E	15/-
	1861	4.0	2.4	FW	500—0—500	120	500	590	4 E	15/-
PIX	60/250	4.0*	0.6	FW	250—0—250	40	230	260	4 E	2/6
	120/350	4.0	2.0	FW	350—0—350	120	350	370	4 E	3/6
	120/500	4.0*	2.0	FW	500—0—500	120	500	570	4 E	4/6
362	RB 350/80	4.0*	1.5	FW	350—0—350	80	350	380	4 E	7/6
	RB 500/120	4.0*	2.0	FW	500—0—500	120	500	550	4 E	10/-
	RB 650/250	4.0*	4.0	FW	650—0—650	250	650	710	4 E	15/-
TRIOTRON	G 429	4.0*	0.3	HW	250	30	250	280	4 D	6/-
	G 470	4.0*	1.0	FW	300—0—300	75	300	350	4 E	7/6
	G 4110	4.0*	2.0	FW	350—0—350	120	350	325	4 E	9/6
	G 4120	4.0*	2.0	FW	500—0—500	120	500	580	4 E	9/6
	G 4120 N	4.0*	2.5	FW	500—0—500	120	500	580	4 E	9/6
	G 4100	4.0*	2.0	HW	750	100	775	850	4 D	14/6
	G 2080	20.0	0.2	HW	250	80	250	270	5 I & Ct. 8 E	9/6
	G 3060	30.0	0.2	2×HW	125	120	125	150	Ct. 8 F	10/6
	G 3412	33.0	0.18	2×HW	125	120	125	150	7 M	10/6
TUNGSRAM	APV 4200	4.0	2.0	FW	350—0—350	120	350	380	4 E	10/-
	APV 4	4.0	2.0	FW	400—0—400	120	425	467	4 E	10/-
	PV 4201	4.0*	2.0	FW	600—0—600	180	575	660	4 E	15/-
	PV 495	4.0*	1.0	FW	350—0—350	80	360	380	4 E	10/-
	PV 4	4.0*	2.0	FW	350—0—350	120	350	390	4 E	10/-
	PV 4200	4.0*	2.0	FW	500—0—500	120	500	600	4 E	15/-
	V 30	30.0	0.2	HW	275	120	265	285	5 I	10/-
AMERICAN	80	5.0*	2.0	FW	400—0—400	110	400	450	A 4 C	—
	81	7.5*	1.25	HW	700	85	—	—	A 4 D	—
	82	2.5*	3.0	FW, MV	500	125	—	—	A 4 C	—
	83	5.0*	3.0	FW, MV	500	250	—	—	A 4 C	—
	83-V	5.0	2.0	FW	400	200	440	495	A 4 C	—
	84	6.3	0.5	FW	350	50	430	450	A 5 F	—
	5 Z 3	5.0*	3.0	FW	500—0—500	250	480	550	A 4 C	—
	5 Z 4	5.0*	2.0	FW	400—0—400	125	450	510	A 8 I	—
	12 Z 3	12.6	0.3	HW	250	60	250	280	A 4 E	—
	25 Z 5	25.0	0.3	VD	125	100	—	—	A 6 J	—
	5 Y 3	5.0*	2.0	FW	400—0—400	110	—	—	—	—
	6 X 5	6.3	0.6	FW	350—0—350	75	—	—	A 8 K	—
	25 Z 6	25.0	0.3	VD	125	85	—	—	A 8 J	—
	5 W 4	5.0*	1.5	FW	350—0—350	110	—	—	A 8 I	—
	1-V	6.3	0.3	HW	350	50	380	440	A 4 E	—

METAL RECTIFIERS

Type.		Capacity (mfd.) of Voltage Doubling or Reservoir Condenser, 50 c/s Mains.	Peak Voltage Rating of Condensers (Working).	Type of Rectifier.	Max. Input Volts (RMS).	Max. Input Current (mA.).	Normal Rect. Current (mA.).	Unsmoothed Rect. Volts at		Price.
								Full-current.	Half-current.	
WESTINGHOUSE	HT 5	4 + 4	200	VD / HW	80 / 135	60 / 30	20	140	170	12/6
	HT 8	4 + 4	350	VD / HW	200 / 375	200 / 90	60	280	440	18/6
	HT 9	4 + 4	400	VD	240	200	60	330	515	21/-
	HT 10	8 + 8	250	VD / HW	150 / 250	300 / 150	100	225	350	21/-
	HT 11	6 + 6	500	VD	300	550	120	530	620	35/-
	HT 12	4 + 4	200	VD / HW	140 / 250	120 / 80	30	230	315	17/6
	HT 13	8	350	HW	150	40	25	150	170	17/6
	H 1	100	12	HW	3.5	15	10	3.6	4	4/2
	H 10	10	50	HW	35	15	10	36	40	4/6
	H 50	2	250	HW	175	15	10	180	205	7/10
	H 100	1	500	HW	350	15	10	360	410	12/4
	H 176	0.5	1,100	HW	620	15	10	650	750	20/-
	J 10	10	250	HW	80 **	3	2	80	—	4/6
	J 50	2	650	HW	400 **	3	2	400	—	7/10
	J 100	1	1,250	HW	800 **	3	2	800	—	12/4
	J 176	0.5	2,000	HW	1,400 **	3	2	1 400	—	20/-
	Two H 120	0.5 + 0.5	700	VD	480	30	10	870	1,000	—
	Two H 176	0.25 + 0.25	1,000	VD	720	30	10	1,300	1,500	—
	Ten H 176	0.05 + 0.05	5,000	VD	3,600	30	10	6,500	7,500	—
	Two J 10	10 + 10	250	VD	0 **	6	2	170	—	—
	Two J 50	2 + 2	650	VD	400 **	6	2	850	—	—
	Two J 100	1 + 1	1,250	VD	800 **	6	2	1,700	—	—
	Two J 176	0.5 + 0.5	2,000	VD	1,400 **	6	2	3,000	—	—
	Ten J 176	0.1 + 0.1	12,000	VD	7,000 **	6	2	15,000	—	—

BARRETTERS

Type.		Normal Current (Amps.).	Range of Volts dropped across Barretter.	Base.	Price.
MARCONI and OSRAM	301	0.3	138—221	Edison Screw	8/6
	302	0.3	112—195	Edison Screw	8/6
	303	0.3	86—129	Edison Screw	8/6
	304	0.3	95—165	Edison Screw	8/6
OSRAM	202	0.2	120—200	4 J	8/6
PHILIPS	1904	0.1	40—70	4 J	12/6
	1933	0.1	50—160	4 J	15/-
	1927	0.18	60—120	4 J	12/6
	1928	0.18	100—210	4 J	15/-
	C 2	0.2	40—100	4 J or Ct. 8 H	12/6
	C 1	0.2	90—230	4 J or Ct. 8 H	10/-
	1920	0.25	40—70	4 J	12/6
	1934	0.25	85—195	4 J	15/-
	1941	0.3	100—240	4 J	15/-

REFERENCES.

- * Directly heated filament.
- HW Half-wave.
- FW Full-wave.
- VD Voltage-doubler.
- MV Mercury Vapour.
- (B) Class "B" valve.
- (Q) QPP valve.
- (D) Driver valve.
- (T) Tetrode.
- † Per pair in push-pull.
- ‡ Under operating conditions quoted.
- (SD) Single-diode.
- (DD) Duo-diode.
- (TD) Triple-diode.
- (P) RF Pentode.
- (H) Heptode.
- (O) Octode.
- (TP) Triode-Pentode.
- (TH) Triode-Hexode.
- ** The mains transformer secondary should be tapped for these rectifiers, as with some specimens a lower voltage is needed to obtain the rated output.
- *** Also available with bayonet type base.
- †† Special double-triode.

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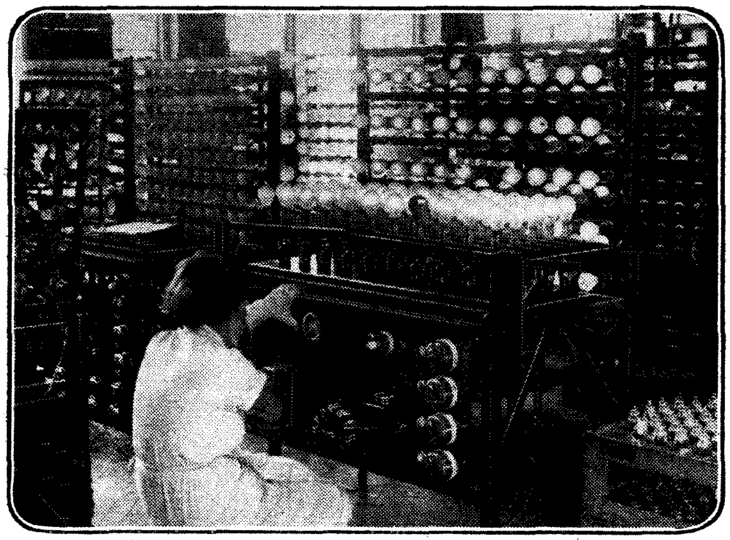
(*Continued from page 534.*)

all other couplings eliminated. With a single stage of amplification having identical grid and anode circuits, the limit of amplification is $A = 2/\omega C_{ga} R_D$ when the valve resistance is high compared with the dynamic resistance. With two stages the number 2 in the above equation should be replaced by 1, with three stages by 0.76, and with four stages by 0.67. With R_D in ohms and C_{a} in microfarads, ω = 6.28 times frequency in Mc/s.

Diode valves are used chiefly as detectors and for AVC purposes. The majority contain two anodes and a common cathode and can provide detection and delayed AVC. In general, they can be safely operated at a much larger signal input than the diodes fitted to the multiple diode class of valve and they often have a lower resistance. Westectors are included in this section since they fulfil the same functions as diodes of the thermionic type.

Multiple Diode Types

Valves which include one or more diodes in addition to another type of electrode assembly are listed in the section appropriate to the major elements. Thus, the duo-diode-triode appears under the heading of "Triodes," while a duo-diode-RF pentode is listed among "Screen-grid" or "Variable-Mu" valves according to whether the pentode section has straight or variable-mu characteristics.



Brimar valves being subjected to the ageing test in the Standard Telephones and Cables factory at Footscray, Kent.

Valves of this nature are very widely used, and in general one diode acts as a detector while the other provides delayed AVC. In the case of a duo-diode-triode the triode section generally functions as an AF amplifier, but with a duo-diode RF pentode the pentode section is normally the last IF amplifier. These valves also find application in amplified AVC circuits.

Triodes

Triodes are divided into two categories: those with a resistance greater than 7,000 ohms and those with a resistance less than 7,000 ohms. The former are now used chiefly as AF amplifiers, grid detectors, and oscillators, while the latter are output or driver valves.

For a grid detector or AF amplifier a valve with a resistance of 7,000-10,000 ohms is usually the best from the point of view of quality, but where high amplification is important a higher resistance can be selected. The deterioration in quality will usually be small and in some cases non-existent, depending very largely upon the circuit conditions.

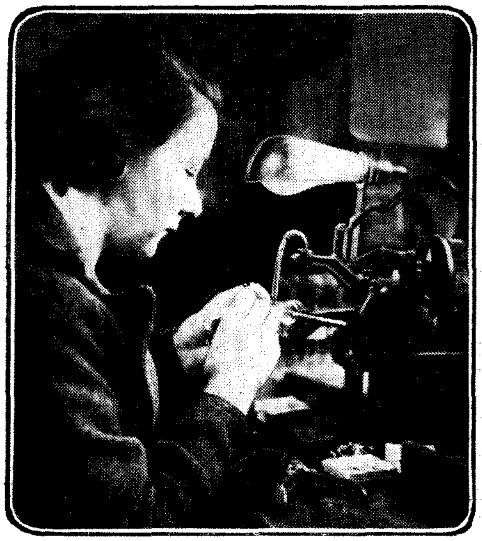
In calculating the amplification from the formula already given it is important to remember that the mutual conductance and AC resistance both depend on the operating voltages. The figures given in the tables are for zero grid bias and 100 volts HT, following the standard practice. The actual values at maximum HT and the optimum negative grid bias are not widely different, but when using resistance coupling it is a wise plan to take the resistance as being about 25 per cent. greater than the figure given and the mutual conductance as about 25 per cent. less.

Valves having resistances below 7,000 ohms are chiefly of the output type and the power output obtainable is undoubtedly the most important characteristic. Unless an adequate output is obtained it is impossible to secure good quality reproduction. The output necessary depends on the loud speaker efficiency and on the volume required. Experience shows that 2,000 milliwatts are needed for ordinary room strength, but that where the very best quality is desired, and particularly when the high and low frequency responses are unusually well maintained, some 4,000 milliwatts should be allowed.

The output figures given are obtained only when the valve is operated into the correct load impedance, figures for which also appear in the tables. The speech coil of the loud speaker rarely has the correct impedance so that an output transformer is necessary, and the ratio is readily calculated by dividing the optimum load impedance by the speech-coil impedance and taking the square root of the result. When the speech-coil impedance is less than the optimum load impedance, the transformer ratio is step-down.

Tetrodes and Output Pentodes

The pentode as an output valve has the advantages of higher sensitivity and efficiency. It is more sensitive in the sense that it requires a smaller signal voltage on the grid for the same power output, and it is more efficient in the sense that it will give the same power output with a smaller consumption of power from the HT supply. In some cases, however, these advantages are more than offset by the high AC resistance of the valve, which



An electric spot welder being used during the assembly of Hivac valves.

leaves the loud speaker undamped, by the necessity for accurate matching of valve and loud speaker, and by the comparatively large amount of third harmonic distortion introduced.

The result is that from the point of view of quality the triode is to be preferred, especially if two can be used in push-pull. Good results can be secured from pentodes, however, particularly if the sacrifice in sensitivity involved in the application of negative feed-back can be tolerated. It should be noted that the optimum load impedance for a pair of pentodes in push-pull is not twice the value for one valve, as it usually is with triodes. The optimum load for two valves is of the same order as that for one, because second harmonics are largely balanced out by the push-pull connection, whereas third harmonics are not, and both are present to an appreciable extent with pentodes.

The tetrodes included in this section are of several different types. There is first the "Harries Output Tetrode" (Hivac) in which the negative-resistance kink in the characteristics of the conventional tetrode has been eliminated by critically spacing the anode from the other electrodes instead of by introducing a suppressor-grid. It is claimed that this results in an improved performance.

The second output tetrode is American, the 6L6 "Beam Power Tube," and is in some ways rather similar. It is a large output valve and is really intended for use in push-pull, since rather a large amount of second harmonic distortion occurs with only a single valve. The best results are secured with two in push-pull and with negative feed-back.

Quiescent Output Valves

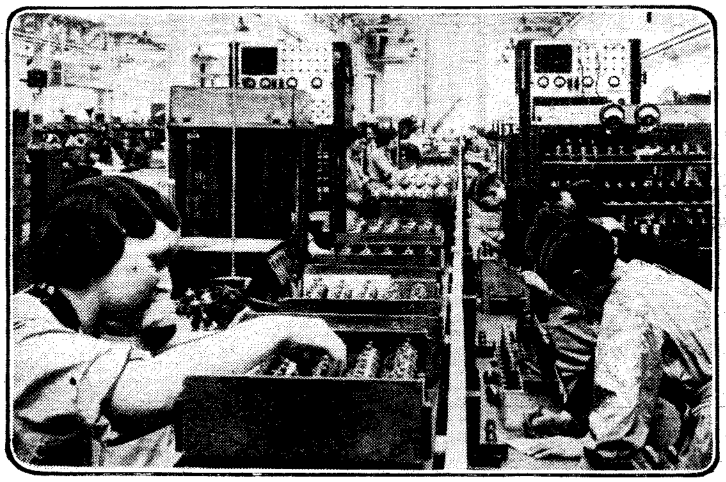
The British valves listed in this section are chiefly battery types. The Class

"Wireless World" Valve Data Supplement—
"B" valve consists of two triodes mounted in a single glass envelope and operated in push-pull. Zero, or only a small negative bias, is used, with the result that grid current flows during a large part of the cycle of input voltage.

The valve characteristics are similar to those of pentodes, so that careful matching to the loud speaker is necessary. It is especially important that the output transformer should have a low DC primary resistance and that the leakage inductance should be small. The valve has a low input impedance and requires a power rather than a voltage input. It *must* be fed from a push-pull transformer having a secondary of low DC resistance and the preceding or driver valve *must* be capable of an adequate power output. The driver transformer usually has a step-down ratio which can be calculated by dividing the optimum load of the driver valve by the input impedance of the Class "B" valve and taking the square root of the result.

Class "B" stages have now been largely superseded by QPP so far as battery sets are concerned. The QPP valve is really a double pentode and a large grid bias is used so that the standing anode current is very small. Grid current does not flow, so that no difficulties arise in the input circuit as they do with the Class "B" stage. The output circuit is treated exactly as any other.

Among the American valves will be found many indirectly heated Class "B" types. These are intended primarily for considerable output in mains-driven equipment, but they are often operated as amplifiers under Class "A" conditions. A single valve will then operate as a complete push-pull stage giving a compact and economical assembly.



Ferranti valves after construction are carried in trays on a conveyor belt to the site of each testing operation.

Rectifiers

Few remarks are necessary on rectifiers, but it is as well to point out that the figures for output assume a 4-mfd. reservoir condenser. This condenser must be rated for working at not less than 1.4 times the RMS AC input to the rectifier. Thus, the reservoir condenser used for a full-wave rectifier with an input of 500-0-500 volts must be rated for working at not less than 700 volts.

There are two general types of rectifier —directly heated and indirectly heated. With the former, the valve functions a few seconds after the set is switched on, so that if the receiving valves are indirectly heated most of the condensers connected, even remotely, to the HT line are charged nearly to the peak value of the AC supply to the rectifier. Consequently, to avoid breakdown, all condensers should have the same voltage rating as the reservoir condenser.

This is avoided with the indirectly heated type, however, for the rectifier does not become operative until the other valves have warmed up and are ready to draw current. Condensers thus need be rated only for the normal working voltages. Care must be taken, however, to choose a rectifier which takes at least as long to become operative as the other valves. If the rectifier cools more slowly than the other valves, there is a risk of a breakdown if the set is switched on within two or three minutes of being switched off, for then being hotter than the other valves to start with, it is operative quicker.

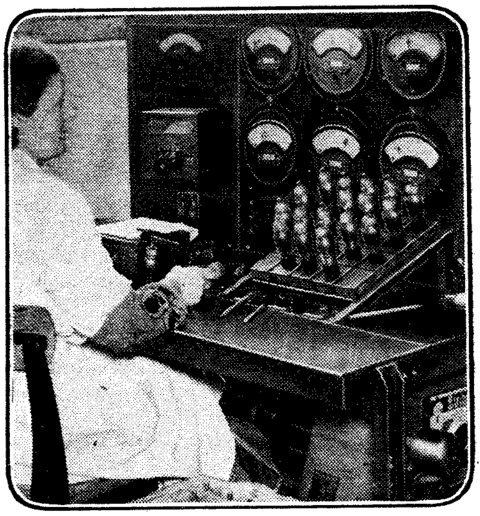
Opinions are divided on the relative merits of the two types. In any case, it is a wise plan to use directly heated valves in the output stage, for then there is always a considerable load on the mains equipment and the possible voltage rise is severely limited.

A number of new rectifiers rated for very high voltages is to be found. These are of the half-wave type and are intended for providing the very small current taken by a cathode-ray tube. They are primarily television valves. The reservoir condenser with these is usually 0.1 mfd.

The data for metal rectifiers is essentially the same as for valves. The capacities of voltage-doubler condensers, however, depend on the mains frequency, the values given being for 50 c/s. With 100 c/s mains the capacities must be one-half the listed figures and with 25 c/s supplies double.

A glance through the tables will show that a considerable amount of additional information is included this year. Where-ever practicable the input and output capacities of valves have been given as well as the grid-anode capacity. These figures are important even in the case of triodes and pentodes because of the high standard of quality which is now demanded, and they are essentials to the design of television equipment.

Each valve, moreover, has its base connections now definitely identified. In every case the figure opposite a valve in the "Base" column denotes the number of pins in the base, while the following letter denotes the connections for that number of pins. A preceding letter is used



Final testing of Brimar valves by taking meter readings of their characteristics.

to distinguish between different arrangements of the same number of pins. Thus, a conventional 4-pin triode is listed as Base 4A, while a 4-pin screen-grid valve has Base 4B. The Midget valves have different pin arrangements and a triode is listed as Sm.4A, being an abbreviation for "small 4-pin base, A connections." Similarly, an American valve base has the prefix A, and Continental types the prefix C. Side-contact types are distinguished by Ct.

The code is an arbitrary one, but is easy to remember, for the numeral and any preceding letters show at a glance the number of pins in the base and the type of base, while the following letter refers to the connections for the particular valve.

In connection with the small 4-pin base for Midget valves, this is used by at least two valve makers, and it should be pointed out that the different makes are not interchangeable. The bases appear the same at a glance and the connections are the same. Actually, however, the pin spacing is slightly different in the Hivac valves from that adopted by Mullard.

SUPPLIERS OF AMERICAN TYPE VALVES

BRITISH AGENTS.

Arcturus.—U.S. Radio, Ltd., 138, Southwark Street, London, S.E.1.
Philco.—Philco Radio and Television Corporation of G.B., Ltd., Aintree Road, Perivale, Middlesex.
National Union.—Universal Radio Distributors, Ltd., 24, Fitzroy Square, London, W.1.
Sylvania.—Claude Lyons, Ltd., 76, Oldhall Street, Liverpool, 3, Lancs.
Triad.—Premier Supply Stores, 20/22, High Street, Clapham, London, S.W.4.

BRITISH MAKERS.

Dario.—Impex Electrical, Ltd., 47, Queen Victoria Street, London, E.C.4.
Triotron.—The Triotron Radio Co., Ltd., 26 Bloomsbury Street, London, W.C.1.
Tungsram.—Tungsram Electric Lamp Works (Great Britain), Ltd., 72, Oxford Street, London, W.1.

A Guide to Valve Bases : BRITISH

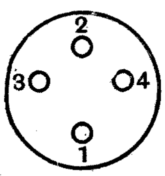
MODERN valve development has led to an increase in the number of external connections to a valve, with the result that many different types of bases are now used. The connections for both British and American valve bases are given in these pages, and it is particularly important to note that the view is of the valve base itself or the underside of the valve holder

ABBREVIATIONS USED IN THE TABLES

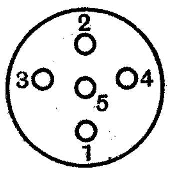
A = Anode.
C = Cathode.
DA = Diode Anode.
DC = Diode Cathode.
Dr = Driver.
G = Grid.
H = Heater.
HCT = Heater Centre-Tap.
IG = Injector Grid.
M = Metallising and metal-shield.
OA = Oscillator Anode.
OG = Oscillator Grid.
R = Resistance.
SG = Screen-grid.
Sup. = Suppressor-Grid.
TC = Top-cap.

NOTES.—Numerical subscripts indicate in multi-electrode valves the order of assembly of the grids, G1 being the grid nearest the cathode, and in multiple valves they distinguish the different electrode assemblies. In one or two cases the now rarely found side-terminal on a valve is included under the column headed TC.

THE BRITISH TYPES



4 PIN



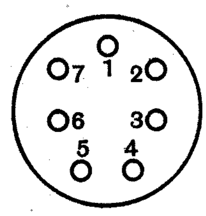
5 PIN

4-PIN BASE CONNECTIONS

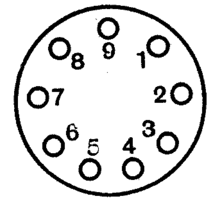
Type of Valve	Base	TC	1	2	3	4
DH Triode	4A	—	A	G	− F	+ F
DH Screen-grid	4B	A	SG	G	− F	+ F
DH Screen-grid	4C	G	A	SG	− F	+ F
DH Rectifier HW	4D	—	A	—	F	F
DH or IH Rectifier FW	4E	—	A	A	F	F
DH Rectifier HW (High Voltage)	4F	A	—	—	F	F
DH Output Pentode	4G	SG	A	G	−F	+ F
IH Diode	4H	—	A	C	H	H
DH Triode	4I	G	A	—	−F	+ F
Barretter	4J	—	—	—	R	R

5-PIN BASE CONNECTIONS

Type of Valve	Base	TC	1	2	3	4	5
IH Triode	5A	—	A	G	H	H	C
IH Screen-grid	5B	A	SG	G	H	H	C
IH Duo-diode	5C	—	DA	DA	H	H	C
IH Duo-diode	5D	DA	DA	M	H	H	C
DH Duo-diode-triode ..	5E	G	A	AVC DA	− F	+ F	Det. DA
DH Pentode	5F	—	A	G	− F	+ F	SG
IH Pentode	5G	SG	A	G	H	H	C
IH Rectifier FW ..	5H	—	A	A	H	H	C
IH Rectifier HW ..	5I	—	A	—	H	H	C
DH Tetrode	5J	—	A	G1	F	F	G2



7 PIN



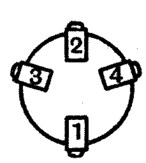
9 PIN

7-PIN BASE CONNECTIONS

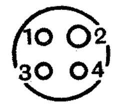
Type of Valve	Base	TC	1	2	3	4	5	6	7
DH Frequency-changer	7A	G	OA	OG	SG	F	F	M	A
IH Frequency-changer	7B	G	OA	OG	SG	H	H	C	A
DH Screened Pentode.	7C	A	M	G	Sup.	F	F	—	SG
IH Screened Pentode..	7D	A	M	G	Sup.	H	H	C	SG
IH Screened Pentode..	7E	G	M	A	Sup.	H	H	C	SG
IH Triode	7F	G	M	—	—	H	H	C	A
IH Duo-diode-triode..	7G	G	DA	M	DA	H	H	C	A
IH Single-diode-tetrode	7H	A	—	G	SG	H	H	C	DA
IH Duo-diode-output pentode	7I	G	DA	A	DA	H	H	C	SG
IH Pentode	7J	—	—	G	SG	H	H	C	A
DH Class "B" ..	7K	—	G2	G1	A1	F	F	—	A2
DH QPP	7L	—	G2	G1	A1	F	F	SG	A2
IH Rectifier, FW or VD	7M	—	HCT	A1	C1	H	H	C2	A2
DH Screened Pentode.	7N	G	M	A	Sup.	F	F	—	SG
IH Pentode	7O	—	Sup.	G	SG	H	H	C	A
DH Driver and Class B	7P	Dr. A	BG2	BG1	BA1	F	F	Dr. G	BA2
IH Pentode	7Q	G	—	—	SG	H	H	C	A
IH Triode	7R	—	—	G	—	H	H	C	A
IH Double-triode ..	7S	—	—	G1	A1	H	H	C	A2
IH Pentode	7T	G	HCT	—	SG	H	H	C	A

9-PIN BASE CONNECTIONS

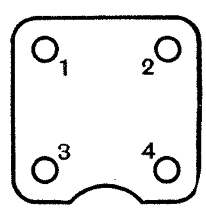
Type of Valve	Base	TC	1	2	3	4	5	6	7	8	9
DH Frequency-changer	9A	G	SG	A	Sup.	F	F	—	OA	OG	M
IH Frequency-changer	9B	G	SG	A	Sup.	H	H	C	OA	OG	M
IH Duo-diode-RF Pentode	9C	G	SG	A	—	H	H	C	AVC DA	Det. DA	M
DH QPP	9D	—	G1	A1	SG1	F	F	—	SG2	A2	G2



Ct. 4



Sm. 4



Lg. 4

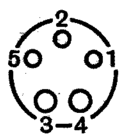
VARIOUS 4-PIN AND 4-CONTACT TYPES

Type of Valve	Base	TC	1	2	3	4
DH Midget Triode	Sm. 4A	—	A	G	F	F
DH Midget Screen-grid ..	Sm 4B	A	SG	G	F	F
DH Large Output Triode ..	Lg. 4A	—	A	F	F	G
DH Midget Triode	Ct. 4A	—	A	G	− F	+ F

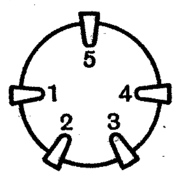
AND AMERICAN TYPES

VARIOUS 5-PIN AND 5-CONTACT TYPES

Type of Valve	Base	TC	1	2	3	4	5
DH Midget Pentode ..	Sm. 5A	—	A	G	F	F	SG
IH Duo-diode.. ..	Ct. 5A	—	DA	H	H	C	DA
IH Duo-diode.. ..	Ct. 5B	DA	M	H	H	C	DA



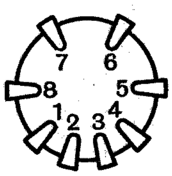
Sm. 5



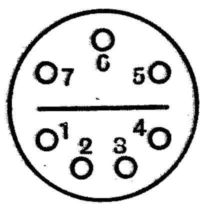
Ct. 5

8-CONTACT TYPES

Type of Valve	Base	TC	1	2	3	4	5	6	7	8
Frequency-changer	Ct. 8A	G	M	H	H	C	OA	OG	SG	A
RF Pentode ..	Ct. 8B	G	M	H	H	C	Sup.	—	SG	A
Triode	Ct. 8C	G	M	H	H	C	—	—	—	A
Output Pentode ..	Ct. 8D	G	—	H	H	C	—	—	SG	A
HW Rectifier ..	Ct. 8E	—	—	H	H	C	—	—	—	A
FW Rectifier ..	Ct. 8F	—	C1	H	H	C2	A1	—	—	A2
Duo-diode-triode..	Ct. 8G	G	M	H	H	C	DA	DA	—	A
Barretter	Ct. 8H	—	—	—	—	—	R	—	—	R



Ct. 8

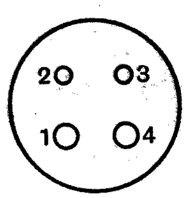


C 7 PIN

OSTAR-GANZ BASE CONNECTIONS

Type of Valve	Base	TC	1	2	3	4	5	6	7
IH Frequency-changer	C7A	G	C	H	H	SG	OG	OA	A
IH Screen-grid ..	C7B	A	C	H	H	SG	G	—	—
IH RF Pentode ..	C7C	G	C	H	H	SG	Sup.	M	A
IH Duo-diode ..	C7D	DA	C	H	H	M	—	—	DA
IH Triode	C7E	—	C	H	H	—	G	—	A
IH Pentode	C7F	—	C	H	H	SG	G	Sup.	A
IH Rectifier	C7G	—	C1	H	H	C2	A2	—	A1

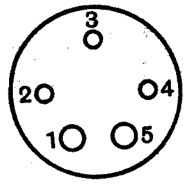
THE AMERICAN TYPES



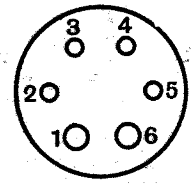
4 PIN

4-PIN BASE CONNECTIONS

Type of Valve	Base	TC	1	2	3	4
DH Triode	A4A	—	F	A	G	F
DH Screen-grid ..	A4B	G	F	A	SG	F
DH Rectifier FW ..	A4C	—	F	A	A	F
DH Rectifier HW ..	A4D	—	F	A	—	F
IH Rectifier HW ..	A4E	—	H	A	C	H



5 PIN



6 PIN

5-PIN BASE CONNECTIONS

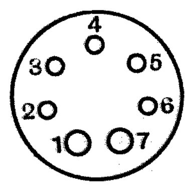
Type of Valve	Base	TC	1	2	3	4	5
IH Triode	A5A	—	H	A	G	C	H
IH Screen-grid ..	A5B	G	H	A	SG	C	H
DH Pentode	A5C	—	F	A	G	SG	F
DH Tetrode	A5D	—	F	A	G1	G2	F
IH Pentode	A5E	G	H	A	SG	C	H
IH Rectifier FW ..	A5F	—	H	A	A	C	H

6-PIN BASE CONNECTIONS

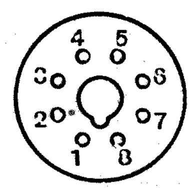
Type of Valve	Base	TC	1	2	3	4	5	6
DH Frequency-changer ..	A6A	G	F	A	OA	OG	SG	F
IH RF Pentode	A6B	G	H	A	SG	Sup.	C	H
DH Duo-diode-triode ..	A6C	—	F	A	DA	DA	G	F
IH Duo-diode-triode ..	A6D	G	H	A	DA	DA	C	H
IH Duo-triode	A6E	—	H	A2	A1	G1	C2	H
IH Duo-triode	A6F	G1	H	A2	G2	C	A1	H
DH Duo-triode	A6G	—	F	A2	G2	G1	A1	F
IH Pentode	A6H	—	H	A	SG	G	C	H
IH Pentode	A6I	G1	H	A	G2	G3	C	H
IH Rectifier, FW	A6J	—	H	A1	C1	C2	A2	H
DH Duo-diode-pentode ..	A6K	G	F	A	SG	DA	DA	F

7-PIN BASE CONNECTIONS

Type of Valve	Base	TC	1	2	3	4	5	6	7
IH Frequency-changer	A7A	G	H	A	SG	OA	OG	C	H
IH Duo-diode-pentode	A7B	G	H	A	SG	DA	DA	C	H
IH Single-diode-pentode	A7C	G	H	A	SG	DC	DA	C	H
IH Duo-triode.. ..	A7D	—	H	A2	A1	G1	G2, C1	C2	H
IH Duo-triode.. ..	A7E	—	H	A2	G2	C	G1	A1	H
IH Pentode	A7F	—	H	A	G2	G1	G3	C	H
IH Pentode	A7G	—	H	A	SG	G	C	HCT	H



7 PIN



8 PIN (OCTAL)

8-PIN BASE (OCTAL) CONNECTIONS

Type of Valve	Base	TC	1	2	3	4	5	6	7	8
IH Frequency-changer	A8A	G	M	H	A	SG	OG	OA	H	C
IH Mixer	A8B	G	M	H	A	SG	IG	—	H	C
IH RF Pentode ..	A8C	G	M	H	A	SG	Sup.	—	H	C
IH Duo-diode .	A8D	—	M	H	DA2	C2	DA1	—	H	C1
IH Duo-diode-triode	A8E	G	M	H	A	DA	DA	—	H	C
IH Triode	A8F	G	M	H	—	A	—	—	H	C
IH Triode	A8G	—	M	H	A	—	G	—	H	C
IH Pentode ..	A8H	—	M	H	A	SG	G	—	H	C
IH Rectifier FW ..	A8I	—	M	H	—	A	—	A	—	H & C
IH Rectifier FW ..	A8J	—	—	M	H	A2	C2	A1	—	H & C1
IH Rectifier FW ..	A8K	—	M	H	A	—	A	—	H	C
Gaseous Rectifier FW	A8L	—	M	—	A	—	A	—	—	C
IH Triode . ..	A8M	G	M	H	A	—	—	—	H	C
IH Duo-triode ..	A8N	—	M	H	A1	G1	G2	A2	H	C
IH Single-diode-triode	A8O	G	—	H	A	—	DA	—	H	C

Broadcast Brevities

NEWS FROM PORTLAND PLACE

Short Waves in O.B. Feature

GREAT things may be expected of the "O.B." Department on December 16th and 18th, the dates of the Trinity House feature broadcast.

Among the highlights will be relays from the lighthouses at Beachy Head, Land's End and Holyhead, the keepers of these lighthouses being heard exchanging views on their jobs. Also, there will be a short-wave conversation between East Coast lightships, the crews describing their work. Two men who spend their lives in looking after buoys and floating lights will also speak, and the whole feature will work up to a climax with a conversation between London river and Southampton pilots, and eavesdropping on an actual conversation between captain and pilot on the bridge of a ship proceeding down Southampton Water.

It should be worth staying indoors to hear such a broadcast as this.

New Year's Eve

FELIX FELTON will again be in charge of the B.B.C.'s New Year's Eve feature programme, beginning at 11 p.m. on December 31st. Mr. Felton works at extraordinarily high speed on the production of his programmes, and it is quite likely that the New Year feature will not be "on the stocks" until a few days before the end of the year.

This quick-fire method of production largely accounts for the spontaneity and verve which always characterise a Felton programme.

Dance music on New Year's Eve will continue until 12.30 a.m. on January 1st, 1937.

Czarist Russia on the Ether

JEANNE DE CASALIS, whom we usually associate with vaudeville "turns" of the "Mrs. Feather" type, is the leading star in "Autumn Violins," a Russian radio drama adapted by Mary Allen for broadcasting nationally on December 4th. The tale is of Russia before the Revolution.

Plays to Come

"TWO plays a week" seems to be the slogan of the Drama Department at Broadcasting House, and every effort is being made to provide listeners with at least this ration of radio drama during the next three months.

Mr. Val Gielgud, the Director of Drama, would be the first to admit that the task is not easy; less than 1 per cent. of new plays submitted harbour even a germ of success, so it is not surprising that recourse must be had either to tried favourites and classics or to those "write-ups" of the past so successfully attempted by Barbara Burnham, Peter Creswell and other members of Mr. Gielgud's team.

Dumas and Chesterton Thrillers

Shakepearean plays scheduled for broadcasting in the near future include "Much Ado about Nothing" and "King John." We are also to hear Dryden's Restoration comedy, "All for Love," and Oscar Wilde's "Lady Windermere's Fan." Dumas' "Twenty Years After" will supply a thriller from the past. G. K. Chesterton's drama "The Man in the Passage," is to be broadcast next February, and Clemence Dane's "Granite" will be heard a month later.

Two features of great literary interest will be devoted to Coleridge and Dr. Johnson respectively.

Tuning-in the Regionals

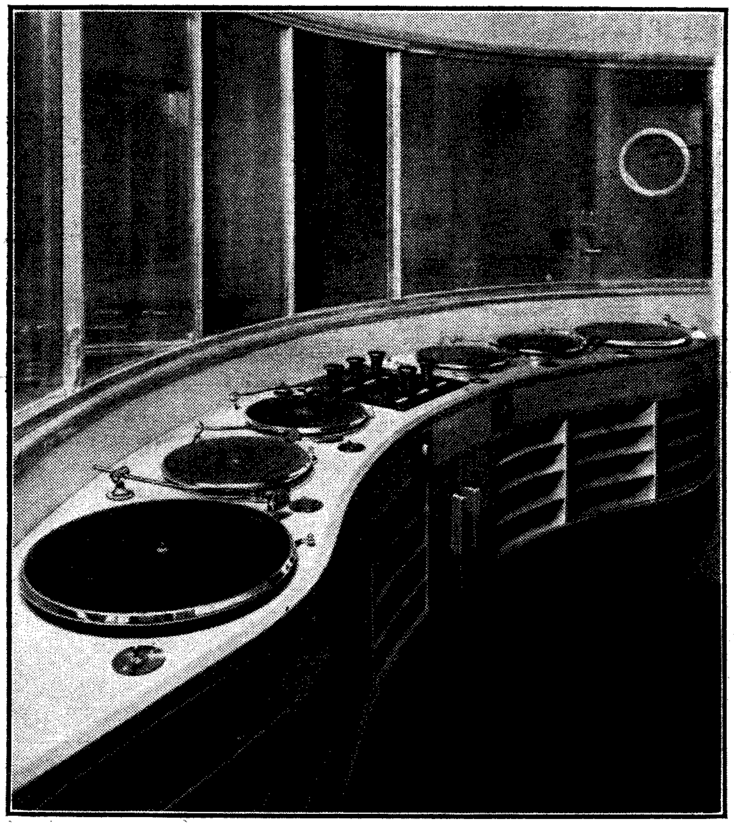
THE Skibbereen Eagle had its eye on Russia, and the Bristol Listeners' Club has its eye on a certain official of the B.B.C. who, a few days ago, said: "Changes may be necessary when the time arrives that wireless sets are capable of picking up programmes from regional stations other than the local stations."

The Bristol Listeners' Club will not take this lying down, and has issued a challenge to the B.B.C. offering to furnish the names of any number of its members who can tune in all the regional stations nightly.

Time marches on!

B.B.C. Relays to Denmark

EUROPE'S fondness for British dance broadcasts, referred to in these columns recently, is again proved by a request received at Broadcasting House from the Danish broadcasting organisation. They ask for, and will be given, a special relay of Geraldo's "Music Shop" feature on Monday next, November 23rd.



FROM CITY TO WOODLANDS, FROM PEACE TO WAR.—The sound effects and atmosphere necessary for the successful "putting over" of a radio play emanate in many instances from the gramophone effects studio. That department in Broadcasting House is shown above and is known as Studio 6E. Six turntables that are connected to a local mixing unit seen in the centre can be individually or simultaneously used.

New Studio Pianos

THE panel of expert judges set up by the B.B.C. to choose pianos best suited for broadcasting have, after exhaustive tests carried out under strict anonymity, made the following choice: The pianos having been divided into three classes to meet the needs of various studios, viz., 9ft. long and over, 7ft. 6in. to 9ft. long, and 6ft. to 7ft. 6in. long, Bosendorfer pianos were adjudged best for the first and third classes, and Steinway and Challen for the second.

Nineteen firms entered thirty-six instruments in answer to the advertised invitation by the B.B.C., eleven being in the first class, seven in the second, and eighteen in the third.

Precautionary

It is noteworthy that in the official statement it is emphasised that this arrangement is subject to the B.B.C. being satisfied with the service provided by the manufacturers and to the particular makes proving satisfactory to the B.B.C. under the heavy wear to which they must be subjected.

Models for Television Scenery

TREMENDOUS possibilities in the use of models for presenting television programmes were demonstrated last week in what was perhaps the most beautiful and effective transmission yet made from Alexandra Palace, viz., the special Armistice Day feature compiled by Cecil Lewis and Dallas Bower.

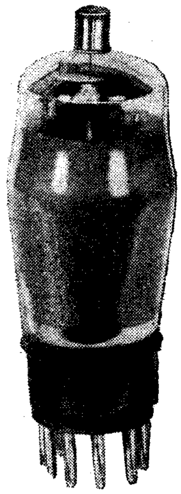
The opening scene depicted a desecrated graveyard at dawn, tumbled crosses being silhouetted against the grey morning sky. Artillery smoke filtered across to the distant roar of guns.

The entire effect was obtained with a tiny cardboard model built up by Peter Bax, stage manager. Across it, from behind, gentle puffs of smoke were blown from miniature bellows. The "artillery" was supplied by the tympani of the Television Orchestra.

Practical Advice

CYNICS are asking why the television transmission on November 28th will include an illustrated talk on "How to Mend a Broken Window." Surely, assert the critics, the man who can afford a television set doesn't mend windows.

Actually, many moneyed folk delight in doing their own household repairs. Louis XVI of France spent much of his leisure picking locks and putting them together again. And many Royalties of to-day are not above home construction of wireless sets.



An All-Stage Valve

AMPLIFIER — FREQUENCY CHANGER — OUTPUT

By J. H. OWEN HARRIES
(Harries Thermionics, Ltd.)

IN the early days of broadcasting it was customary to use the same type of valve in every stage of a receiver. As design progressed, however, it was realised that different characteristics were needed if the varying functions of the different stages were to be carried out efficiently. This led to the multiplicity of valves which we know to-day and to a state in which it is not uncommon to find a different type of valve in every stage.

There is no doubt whatever that different stages in a receiver do require valves with different characteristics, but this does not necessarily mean that the valves themselves cannot be the same. A multi-electrode valve can be made to assume a wide variety of characteristics according to the potentials applied to the various electrodes and to the way in which they are connected.

This principle has been adopted in the Harries All-Stage valve, which is so designed that it can be used in any stage of a normal receiver merely by connecting it appropriately. The valve is of the multi-electrode type having five grids and a "critical distance" anode.[1] This factor of critically spacing the anode from the other electrodes is important not only because it increases the linearity of the characteristics and so reduces amplitude distortion, but also because it renders possible the construction of an *efficient* "all-stage" valve. Such a valve may be employed to perform the function of most existing valve types by suitably connecting the grids, and it will also permit the use of some circuit arrangements not possible with other types.

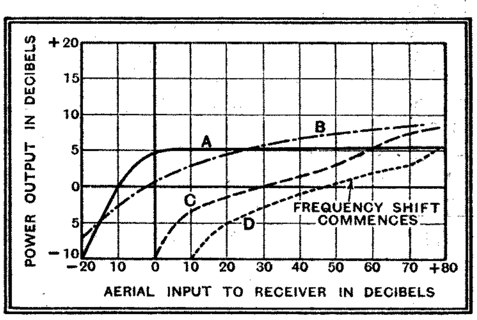


Fig. 1. The AVC characteristics of a superheterodyne embodying All-Stage valves are shown by curve A, while those of three typical receivers of ordinary type are illustrated by B, C, and D.

The valve is indirectly heated and consumes some 4 watts; it is rated for maximum anode and screen potentials of 300 volts and 250 volts respectively. When connected as a frequency-changer a conversion conductance of 0.5 mA/v. is obtained with an AC resistance of 1 megohm. As a voltage amplifier for RF, IF or AF circuits the mutual conductance is 2.5 mA/v. with an AC resistance of 1.2 megohm and a grid-anode capacity of only 0.001 m-mfd. Connected in this manner the valve takes an anode current of 5 mA., but when operated as an output valve it consumes 32 mA. and has a mutual conductance of 5 mA/v. The valve may also be connected to function as a single-diode-triode or -tetrode.

Improved AVC

One of the most interesting properties of the valve is in connection with AVC systems, for it enables many of the difficulties of present methods to be overcome. As Cocking has pointed out,[2] the usual AVC systems are unsatisfactory and are really a compromise between cost and simplicity on the one hand and performance on the other. The ordinary systems are anything but distortionless.

The difficulties are overcome in the case of the All-Stage valve by applying the signal and the AVC voltages to different grids. In this way, linearity of characteristic can be retained while a very large change of mutual conductance for a given change in bias voltage can be secured.

The AVC characteristic of a four-valve superheterodyne employing All-Stage valves is shown by the solid-line curve of Fig. 1, while the results with three typical commercially produced receivers of to-day are illustrated by the other curves. Not only is the range of control greater, but the output is maintained at a more constant level.

The superiority of the new system is even more apparent when distortion is considered. The performance in this respect is indicated in Fig. 2, in which the overall distortion of the four receivers already mentioned is given. The method of measurement entails the use of a standard signal generator having itself a very low distortion level.[3] Two different modulation frequencies are used simultaneously and the side tones caused by intermodulation are measured; it can be shown that this gives a much better measure of distortion than the usual procedure based upon harmonics of a single-frequency input.

When there are no side-tones, distortion is zero. Experience shows that 5 per cent. second side-tone is not serious, but larger amounts are audibly objectionable. Up to 20 per cent. or even 30 per cent. of the first side-tone can be tolerated, however, but very small amounts of side-tones higher than the second are serious, and coincide with harsh reproduction.

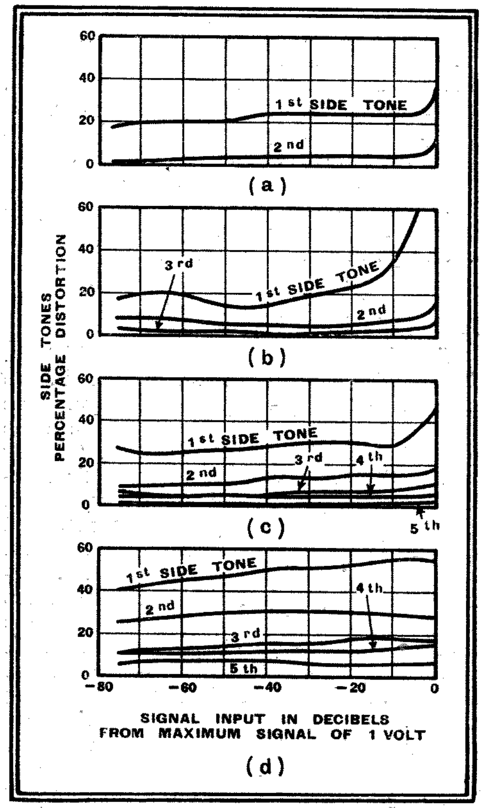


Fig. 2. The percentage side-tones introduced for the four receivers of Fig. 1 are shown here. The small amount of distortion introduced by the All-Stage valve is well brought out in (a).

Bearing these figures in mind, it can easily be seen from Fig. 2 that the degree of distortion introduced by the receiver embodying the All-Stage valve is considerably lower than that with the others, and this is audible as an appreciable improvement in the quality of reproduction. Moreover, there is also an improvement in noise level and cross-modulation.

At the time of writing, the valve is not yet generally available, but it is anticipated that it will shortly be marketed by the High Vacuum Valve Co., Ltd., in conjunction with whom the production model of the valve has been developed.

[1] *The Wireless Engineer*, April, 1936.

[2] The Design of AVC Systems: *The Wireless Engineer*, August, September and October, 1934. Developing a Modern Quality Superheterodyne, *The Wireless World*, Feb. 14th, 1936. Is Automatic Volume Control Worth While? *The Wireless World*, May 22nd, 1936.

[3] *The Wireless Engineer*, October, 1936.

Random Radiations

By "DIALLIST"

Television Far

AFTER seeing a good many television programmes, I am beginning to wonder whether we quite know what to do with this new development now that it is ours. I know that the programmes are still officially described as experimental, and I don't want to be over-critical; but for all that I can't feel that the fare provided is quite what it might be. Two hours a day is probably as much as we have any right to expect now, but those two hours should furnish first-rate entertainment of a kind that can be had in no other way. I don't think that the evening programmes should be to a great extent a rehash of the afternoon's, as not infrequently it is. Nor am I convinced that it is right to transmit—remember, this service is for the London area—news-reels which can be seen better at the cinema. The success of television, both as a popular hobby and commercially, must depend very greatly upon what is televised. Ordinary broadcasting leapt into immediate favour largely owing to the thrills that it provided, and continued to provide for some time, as distant stations were brought more and more easily within the scope of Mr. and Mrs. Everylistener.

A Sophisticated World

Television can't have the same history. Its thrills have been discounted in no small measure by lay-press publicity. The amateur cinematograph has made the home presentation of moving pictures a familiar thing. Television comes to a public fourteen eventful years more sophisticated than that which was so ready to welcome sound broadcasting that it didn't much care what it heard so long as it heard something. Hearing at a distance without connecting wires was a wonder then; seeing at a distance is no longer a wonder. Only last week I took two elderly ladies to see television for the first time. They said it was remarkable; they increased the tale of my grey hairs by asking to be given a simple explanation (oh, those simple explanations!) of how it was done. But they accepted the whole thing as calmly as if it had been a new kind of vacuum cleaner. They were far less concerned with the marvel of television than with criticising the clearness of the images, the size of the viewing screen, and the entertainment value of the transmission. Shortage of money is the probable reason why the present programmes are what they are. Television is such an enormous thing—how enormous we haven't yet realised—that it must not be starved in its infancy by lack of financial nourishment.

Pernickety Short Waves

WHAT queer things the short waves are! Of late they've given us some excellent samples of the tricks that they can play. One evening, for instance, you find an American station coming in with almost "Droitwich" strength. The next day it's possibly every bit as good; but when you try for it the day after that you may find that it just isn't there at all. I struck one of those very bad patches that do occur every now and then when a friend asked me the other evening to let him hear what a typical "all-wave" set could do on the short waves. Except for a few of the European "locals," most of which were hardly up to the mark, I could find nothing at all that was worth listening to. He left me at about half-past ten, and shortly after his departure I switched on again, to find the short wavebands very much alive. Things are not often quite so bad as that, but I can't help feeling that it would be sound policy on the part of makers of "all-wave" sets to make it plain that, whilst long-wave and medium-wave reception of distant stations is a certainty nowadays, the short waves are always apt to be something of an adventure.

My Dream Set

READING in a recent issue of *The Wireless World* a brief description of the new 37-valve Crosley receiver started me speculating on the number of valves that I'd have in my ideal set and the way in which they would be used. There wouldn't be 37, for this giant American set is apparently designed for far greater volume than I should ever require. I am one of those who like their wireless reproduction to be not too loud—*and* I have neighbours. My ideal set would cover all wavelengths from about 7 to 2,000 metres in five or six tuning ranges. I ask for real sensitivity, but I want to be able to cut out between-station noises. Selectivity would have to be variable to fulfil my requirements, but I'd prefer it to be manually adjusted rather than automatic. AVC must be really effective on all wavebands, which means that it would have to be applied to a good many valves. I want my oscillator to be free from creeping when I'm listening to short-wave stations. The quality of reproduction must be good with freedom from background noises. This seems to indicate two audio-frequency stages, both of the push-pull variety.

The Valves Needed

We could accomplish all this very nicely, I feel, with twenty valves, none of them being of more complicated type than the variable-mu HF pentode. A signal-frequency stage is clearly necessary, followed by a first detector, an oscillator, and an oscillator amplifier. The purpose of the last is largely to ensure wobble-free working. Three IF stages—don't you think?—all working comfortably within themselves. Then diode second detector, AVC amplifier and AVC valve. The first AF and output push-pull stages account for four more valves. And a "squelch" valve, a pair for automatic tuning correction, and one for tuning light control, and the total, so far, is eighteen. Two rectifiers bring it up to twenty—you'd probably need two rectifiers for completely satisfactory results with such an array. Wouldn't a set like that be a joy to handle? Provided, of course, with full band-spreading on its short-wave ranges it would be delightfully easy to operate. There would be none of that business of trying to work a station up to reasonable audibility by feats of hairbreadth tuning. Any station worth hearing would be very much in evidence.

The Joys of the Big Set

Probably you've handled a big receiving set now and then; you may, of course, be fortunate enough to possess one. In either case you'll agree with me that it is a sheer joy to work the controls. It's a pretty sound maxim that a station is seldom really worth hearing if the manual volume control knob has to be turned much more than about half-way from its minimum position. With the small receiver how many short-wave stations are there that you can get in this way? Except at times when conditions are phenomenally good there are very few outside the locals—and all European short-wave stations count as locals. How different it is when the big, genuinely sensitive set is in action. Instead of feeling that you're working it up to the very last notch (and wishing as often as not that there were one or two more!) you have the pleasant impression that there is always lots in hand. The small receiver seems too often like a little car, hopelessly overloaded with passengers and baggage, and labouring up a steep hill. You want to change down, but you know that you are already in bottom gear. The big set is like the powerful car which floats up hills on top.

Saying it with Kilowatts

SOMEHOW I feel rather glad that I don't live within a mile or two of the Roosevelt Automobile Raceway at Mineola, L.I., U.S.A. You see, they have just installed what is claimed to be (and I hope always will be) the world's largest battery of loud speakers for the purpose of keeping the crowds which watch the motor racing *au fait* with what is going on. No fewer than nineteen loud speakers, each weighing over five hundredweights, have been fixed up at the top of a 100ft. high lattice tower. Each of these is served by its own 1,000-watt amplifier; and, in addition, there is a further dozen loud speakers of smaller size nearer the ground to serve those who are watching from the grandstand. It is stated—and I willingly believe it—that the voice of this array is 100,000 times louder than the loudest human shout. The noisiest giant aeroplane with its many engines develops but a hundredth part of the din that this dread loud speaker assembly can produce when called upon. Hitherto I have always looked upon the wireless valve as something entirely beneficial to humanity. But if it is going to be made to do this kind of thing . . .!

Time on the Air

The statement that the various political parties in the States had between them to foot a bill for £400,000 for the use of broadcasting stations during the recent presidential election gives one to think a bit. What a spate of oratory must have poured from the loud speakers of American homes—unless, of course, prompt and frequent use was made of the main switch! That's one of the great things about wireless: though you can't answer back or heckle, you can always switch off a speaker whose opinions you don't like, or turn to another station. Anyhow, I'm glad that "time on the air" cannot be bought by our politicians from the B.B.C. It's all very well to give the leaders of the different parties twenty minutes or so at the microphone just before elections; we like to know what they've got to say. It's always jolly to learn that, with hands firmly on the tiller, and leaving no stone unturned nor avenue unexplored, they are firmly resolved to plough that straight furrow which will enable the ship of state to soar triumphant to the skies. But that's a very different thing from turning loose upon us anyone who can plank down enough to hire a broadcasting station for a while. May it never come to that in this land of ours!

Club News

The Derby Wireless Club

A silver jubilee dinner was held recently by the Club in order to commemorate the twenty-fifth anniversary of its foundation. This club, which was founded six months after the birth of *The Wireless World*, claims to be the oldest in existence. At the dinner two of the founder members, Mr. Sancroft Taylor and Mr. Allan Treveleyan Lee, were presented with suitably inscribed gifts.

Southend and District Radio and Scientific Society

A very successful field-day was held on a recent Sunday. The transmitter operated on a wavelength of 155.8 metres and was concealed in a lane near Barling. Four of the eight search parties succeeded in locating the transmitter, and an enjoyable tea party was subsequently held at Leigh-on-Sea. It was unanimously agreed to hold a similar field-day in the future. Full details concerning the society's activities can be obtained from the Hon. Sec. at "Chippenham," Eastern Avenue, Southend-on-Sea. The society's headquarters are at Glendale College, Chalkwell Avenue, Westcliff-on-Sea.

The Exeter and District Wireless Society

An enthusiastic talk on the elimination of hand-capacity effects with short-wave receivers was given early this month by Mr. A. J. Batten, who also demonstrated his receiver. On Monday, November 23rd, at 8 p.m. Mr. Stanley Brown, A.M.I.W.T., of the Chloride Electrical Company, will give a lantern lecture on "Modern Radio Batteries," while on the following Monday at the same time Mr. F. J. Thorn will give a lecture and demonstration on "Modern Receivers and the Dipole Aerial." Full details concerning the Society, which meets at 8 p.m. every Monday at the Y.W.C.A., Dix's Field, Southernhay, may be obtained from the Hon. Secretary, 9, Sivell Place, Heavitree, Exeter.

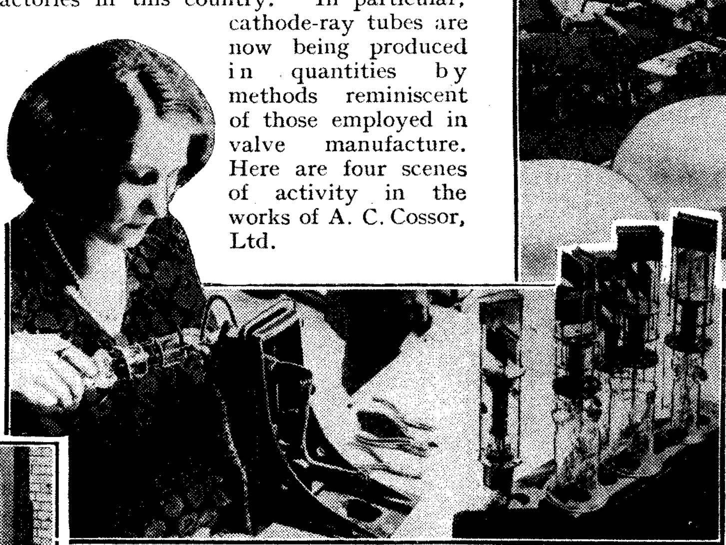
Golder's Green Television Lectures

Lectures on the principles, design and construction of television receivers are being arranged for the near future by the Golder's Green and Hendon Radio Scientific Society. The first, on November 25th next, will be devoted to the sound receiver, and possibly accompanied by a demonstration. On December 9th the principles of vision reception will be dealt with.

Both meetings will be held at the Regal Cinema, Golder's Green, commencing at 8.15 p.m., and anyone interested in these aspects of television will be welcome.

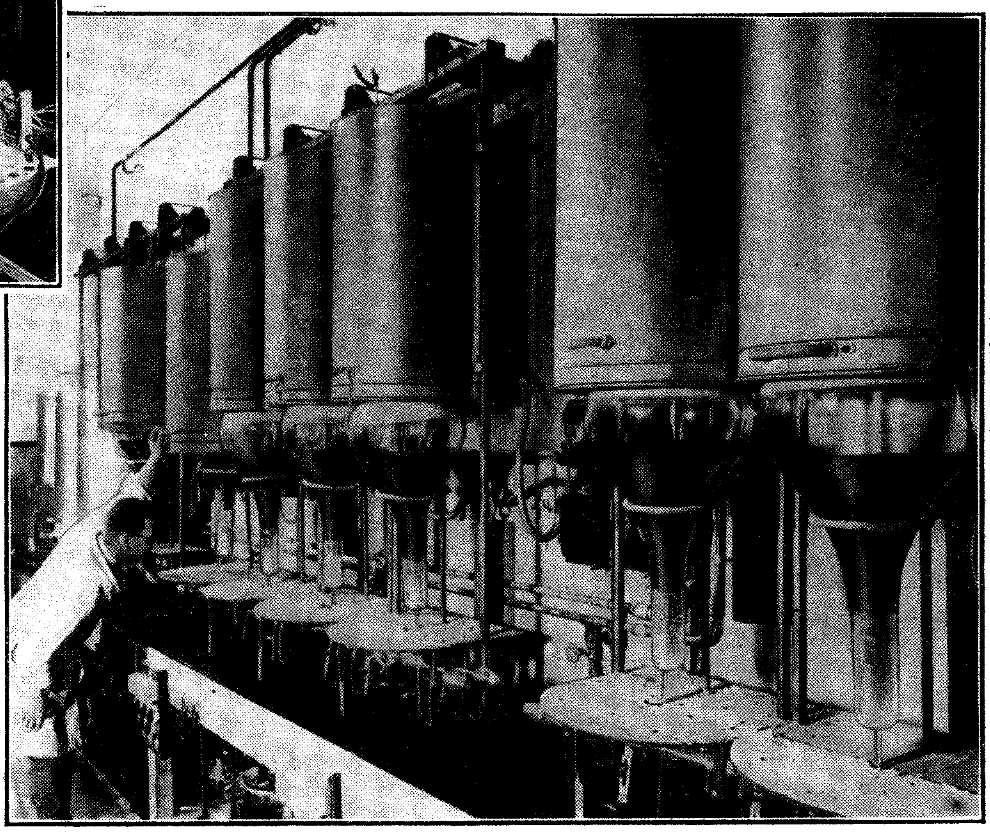
Television Gear in the Making

THE production of television accessories and complete receiving sets is now in full swing at most of the leading wireless factories in this country. In particular, cathode-ray tubes are now being produced in quantities by methods reminiscent of those employed in valve manufacture. Here are four scenes of activity in the works of A. C. Cossor, Ltd.



Electrodes of cathode-ray tubes being assembled on the left, and below, twelve-inch tubes with electrodes inserted undergoing the process of evacuation at one of the batteries of vacuum pumps, prior to the bulb being capped, which operation is shown above.

On the left, a part of the assembly shop, showing receivers in various stages of construction.



Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

LOUD SPEAKERS

TO increase the frequency range of a loud speaker, a small metal cone with its apex pointing outwards, *i.e.*, in the reverse direction to the ordinary diaphragm, is secured to or formed as one with the cylinder or former on which the driving-coil of the instrument is mounted.

British Thomson-Houston Co., Ltd., and J. Moir. Application date February 8th, 1935. *No.* 451664.

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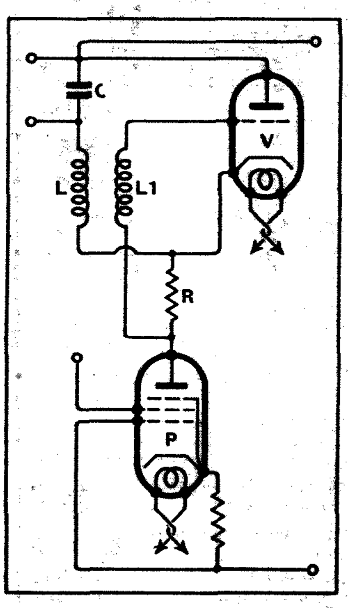
TIME-BASE CIRCUITS

A CONDENSER C is charged through a constant-current device, such as a pentode P, and is discharged by a triode valve V so as to produce saw-toothed scanning oscillations which are fed to the deflecting electrodes of a cathode-ray tube as used in television receivers. When the condenser is charging-up, the current through the resistance R keeps the grid of the valve V negative, and this negative voltage is increased by the inductive coupling between the coils L and L1. When the valve V begins to discharge it passes more current than is provided by P, and the grid voltage accordingly becomes more positive. At the same time the decrease in the current through the coil L induces a voltage in the coil L1 which "flicks" the grid still more positive, and so accelerates the discharge through the valve V. The net effect is to "snap" the valve V into and out of action.



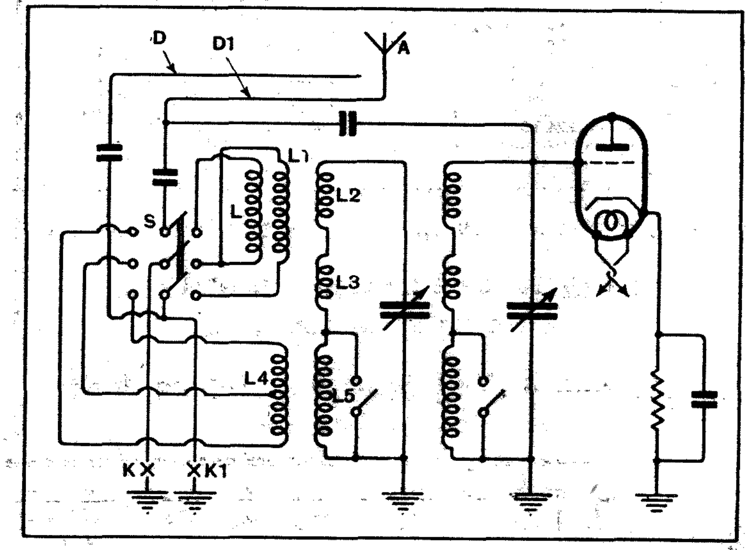
Time-base circuit for cathode-ray tubes.

General Electric Co., Ltd., and D. C. Espley. Application date March 8th, 1935. *No.* 450986.

TUNED INPUT CIRCUITS

THE tendency in present-day circuit design is to use high-quality coils of small size which, because they take up less room in a receiver, can be more conveniently "spaced," having regard to the coupling and mutual inductance desired, particularly in band-pass input circuits. The circuit shown in the figure is designed with this object, and also to reduce local interference when used in combination with a twin lead from the aerial.

The aerial A is connected through a two-wire down-lead D, D1 to a wave-change switch S, which, in the right-hand position, is set for the medium waves and, in the left-hand position, for long waves. In the first position the aerial is connected to two bifilar wound coils L, L1, which are closely coupled to the coils L2, L3, and so to the input valve. Any inductive interference picked up by the two-wire down-lead is balanced out in the coils L, L1 when the switch K is closed and the switch K1 opened. If no interference is present the switch K is left open and the switch K1 closed, so that the second down-lead D is disconnected. On the long-wave position the aerial is coupled to the set through the coils L4, L5.



Band-pass input circuit designed for suppression of local electrical interference.

E. K. Cole, Ltd., and G. Bradfield. Application date April 26th, 1935. *No.* 451301.

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DIRECTIONAL AERIALS

WHEN taking the bearings of a distant transmitting station—or when ascertaining the point of origin of atmospheric disturbances—it is necessary to use a directional receiving aerial which is not affected by variations in the polarization of the received waves or impulses. Otherwise the critical point of minimum reception is "blurred," and accurate reading becomes impossible.

Accordingly, in place of a single frame aerial, four separate frames are used, each set at the corner of a square. These are coupled to a central receiver by horizontal transmission lines, with no sensible coupling between them except that due to the signal currents from each of the frames.

Opposite pairs of frames are opposed to each other in the common receiver, and the unbalanced voltages are applied to a cathode-ray tube, which shows directly on its screen the direction from which the signals arrive.

R. H. Barfield. Application date February 19th, 1935. *No.* 452290.

CONVERTING ELECTRICITY INTO LIGHT

A HEATED filament is backed by a reflector so as to focus the electrons to a beam which is projected on to a quartz crystal. Variation in the intensity of impact of the electrons on the crystal is stated to produce light of corresponding intensity. The arrangement is used for television.

H. P. Pratt. No. 2048517. *(U.S.A.)*

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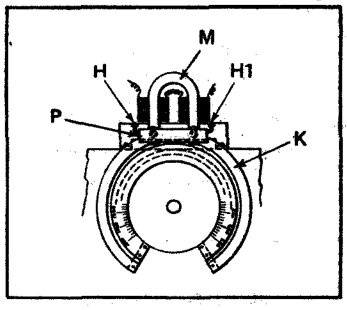
TUNING CONTROL

IT is pointed out that in a receiver provided with means for suppressing interstation "noise," the apparent increase in the sensitivity of the valves brought about by the AVC control makes the tuning more critical, so that it becomes difficult for an unskilled operator to leave the circuits truly in resonance with the incoming carrier wave.

To overcome this difficulty the tuning condenser is automatically clamped in the position at which the incoming carrier-wave is at maximum strength. The figure shows a horseshoe magnet M which is energised by a control valve, dependent in turn upon the AVC voltage produced at resonance. The poles of the magnet attract a plate P, which is hinged at H, H1, and force it inwards against the top of the tuning knob K so as to hold the latter against further movement. The arrangement is particularly suitable for remote tuning control systems.



Magnetic brake to ensure accurate tuning of a receiver embodying muting circuits.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of L. E. Barton. Convention date (U.S.A.) December 1st, 1933, *and February 28th,* 1934. *No.* 451346.

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TELEVISION SYSTEMS

IN presenting a television picture, two kinds of variations in "overall" brightness may occur. For instance, (*a*) when a man is being televised in evening clothes and the illumination of the scene is changed by switching more lamps, and (*b*) when he turns his back to the scanner, so that an expanse of white shirt is more or less suddenly replaced by dark cloth. Owing to the effect of the D.C. component of the transmitted signal the result on the received picture, in the second case, is that the part formerly occupied by the white shirt front will for some little time appear to be grey, whilst the background appears to grow brighter.

According to the invention, the reinserted D.C. component is controlled by a circuit comprising two photo-electric cells, one of which is affected by the total brightness of the scene, whilst the other responds only to the brightness of a suitably chosen screen or surface illuminated by the same general light as the scene being televised. In this way the amplitude of the transmitted signal can be kept substantially constant, and the image signal is automatically controlled so that it increases when the general illumination falls off and vice versa. In other words, only differential changes in brightness, and not overall changes of illumination, control the value of the reinserted D.C. component, and hence the brightness of the received picture.

J. C. Wilson and Baird Television, Ltd. Application date February 8th, 1935. *No.* 451663.

The British abstracts published here are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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CONTENTS

EDITORIAL COMMENT

The Broadcast Licence

A Question of Interpretation

THE latent ambiguity in Statute law is once again emphasised by the dismissal recently at Marylebone Police Court of a summons taken by the Postmaster-General against the tenants of a block of London flats for receiving broadcast programmes without a wireless licence.

The P.M.G., in his capacity as trustee of the ether—which includes the ultimate control of broadcasting—has always maintained that the legal liability to take out a licence depends upon the tenancy of the premises in which the set is installed. A sole tenant may use as many sets—or loud speakers—in his own house, as his inclination fancies, and cover them all with a single licence. But where there are different tenants in the same house—or block of flats—then each tenant must take out a separate licence in respect of his own apparatus.

Up to the present, this contention appears to have been upheld by the Courts whenever the P.M.G. has asked them to enforce it, so that the Marylebone ruling is bound to come as something of a bombshell both to the powers-that-be, meaning the P.M.G. and the B.B.C., as well as to those listeners who have already accepted the contention as legally established and have paid their yearly tribute accordingly.

The Magistrate based his decision on the wording of the present Act, which obliges a person to take out a wireless licence before "installing or working apparatus for wireless telegraphy."

"I find," he says, "that 'working' must mean 'tuning-in' . . . I do not think that plugging-in to a set in another flat constitutes 'working' any more than would the opening or shutting of a door to admit or exclude the sounds from that set."

There for the time being the matter must rest, though we hardly think the last word has been spoken.

To us it appears that the position of relay services, too, is intimately associated with this question.

Many of our readers will recall a somewhat similar position which arose over the interpretation of the word "transmission" as used in the Wireless Telegraphy Act of 1904. That Act forbade the *transmission* of messages by wireless telegraphy, except under licence, and heated arguments arose, when the broadcast service started, as to whether the word also covered the *reception* of the B.B.C. programmes. If it did not, there was an end to the broadcast service, which obviously could not be run without an income. In this case the ambiguity was removed by the Wireless Telegraphy (Explanation) Act, which made it clear, without any shadow of doubt, that transmission includes the reception as well as the sending of wireless messages.

Short Wave Record

South Africa Receives Alexandra Palace

ELSEWHERE in this issue we publish a log of reception at Johannesburg of the sound transmission of the Alexandra Palace programmes. The items recorded as heard have been substantially verified as emanating from the television station. We believe that this reception over a distance considerably in excess of 5,000 miles must indeed constitute a record for this frequency and open up interesting possibilities for the future, even to the point of visualising that reception of the picture transmissions themselves might prove possible at such distances under specially favourable conditions.

Wireless Education

Definition of an Engineer

COMMENTS in our issue of November 13th on the question of the status and qualifications of wireless engineers have brought forth opinions which we publish in this issue from various authorities. We are glad to find that the difficulties are recognised and that a good deal is to be done to remedy the present state of affairs.

Sound Recording

PART I. — POSSIBILITIES AND LIMITATIONS OF SYSTEMS FOR HOME USE

By S. R. EADE, A.M.I.E.E. (Of the Research Dept., B.T.H. Co., Rugby)

ALL known sound-recording systems may be classified under four headings or combinations of these four. They are: photographic; mechanical; magnetic, and chemical. Each of these four broad classes may be further sub-divided as follows, but this list must not be taken as necessarily complete.

Photographic records may be of constant photographic density and of varying width; of varying photographic density and constant width or a combination of these two. The essential feature is that the record shall offer a light transmission which is proportional to the frequency and amplitude of the sounds recorded. We have such records in the following forms: (*a*) 35 mm. sound on film—the commercial size used for cinema projection. (*b*) 16 mm. sound on film—the sub-standard size. (*c*) Multi-track records on 16 mm. or 35 mm. film for use with long-playing reproducers when a picture is not required. (*d*) Helical tracks on cylinders of sheet film for similar purposes to (*c*). Negative records in this form have been printed to give positive printers' ink copies on paper which may be reproduced in a similar way. (*e*) Special photographic records such as the circular tracks on glass discs used in the G.P.O. speaking clock.

Mechanical, Magnetic and Chemical Systems

Mechanically produced records usually consist of a narrow spiral or helical track in a suitable disc or cylinder, this track being modulated either transversely or vertically with respect to the record base. Examples are: — (1) The conventional gramophone record which is a transversely modulated spiral groove. (2) The high fidelity "hill and dale" record of the Western Electric Co., which is a vertically modulated spiral groove. (3) Edison's original phonograph was a vertically modulated helical track in a cylindrical record, and the "Ediphone" used in offices is a modern example of this system. (4) Transversely or vertically modulated tracks in flexible strip, such as gelatine or the acetate base of cinematographic film. (5) Composite methods such as the Philips' system of a variable area form of record produced by mechanical means, but reproduced by means similar to those used with purely photographic records.

In magnetic systems, sound is recorded in a magnetic material by producing in it a permanent change of its molecular arrangement proportional to the frequency and amplitude to be recorded. As a record material, steel tape, steel wire and various flexible non-magnetic supports coated with ferrous compounds have been used.

A commercial system is the Blatnerphone.

Various chemical methods have been proposed in which the sound to be recorded, in its electrical form, is arranged to produce a visible chemical change in a specially treated record material. The record, as in photographic methods, can be of variable width or variable density form, and the result will be reproduced in a similar way.

No commercial system is in use.

In any method of recording sound the ultimate aim must be to obtain a record from which can be reproduced without distortion sounds of all frequencies within the limits of audibility of the average human ear over a power range such that the pressure reaching the ear can vary within the pressure limits for the average ear.

THE very considerable interest shown by readers of "The Wireless World" in all matters relating to the recording of sound has suggested these articles. The writer first states the problems involved and then, by an analysis and description of the known methods of recording sound, attempts to predict the probable direction of future development in apparatus for home use.

Fig. 1 shows the well-known auditory sensation curve for the human ear. Sound pressures (or "volumes") outside the lower boundary curve are inaudible, while those above the upper curve are so loud that they are felt rather than heard and tend to become physically painful. If the sound pressure at any frequency is gradually increased step by step from a value denoted by the lower curve, the ear can appreciate the changes until the upper boundary curve is reached. After this point, increases in intensity cannot be detected.

From this curve it will be seen that the audible limits of frequency and pressure for the average ear are:—

Frequency: 20-20,000 cycles per second.
Pressure: 4×10^{-3} to 4×10^{3} bars.
Power: 3×10^{-9} to 4×10^{4} microwatts.

No sound-recording method at present in use can provide this ideal range of pressures, and to obtain the ideal of frequency range is also very difficult; luckily, a very much restricted range will permit of good quality sound.

Fig. 2 shows the fundamental frequencies corresponding to the piano scale together with the range of many musical instruments. It will be seen that a range up to 5,000 cycles would include most fundamentals, but this must, of course, be increased if the overtones or harmonics are to be included. It is these harmonics which give the character to each individual instrument and human voice, and the frequency range should ideally be extended to the limit of the ear audibility curve or 20,000 cycles for optimum quality. It has been found, however, that if we provide a frequency spectrum of 30 to 10,000 cycles we can obtain quality which from this point of view is almost perfect.

Reverting now to volume range, the peak value accepted by the average ear is 137 db., as shown in Fig. 1. This value, however, is never required at one time, because it can be shown that the volume limit for average speech is only 57 db.,

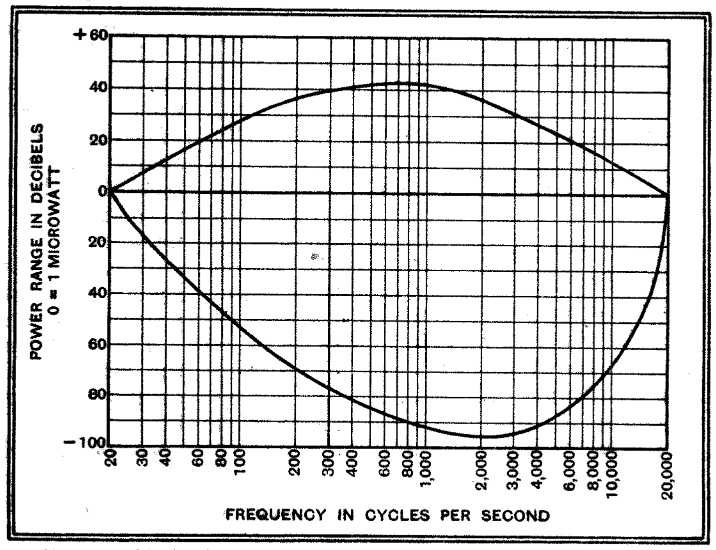


Fig. 1.—Limitations of the human ear. Sounds below the intensity represented by the lower curve are inaudible while those above the upper curve tend to become painful.

Sound Recording—
whilst that for a full orchestra is 70 db. These two may not, of course, cover the same part of the curve in Fig. 1, because the lowest level of the orchestra will be considerably in excess of, for instance, the level of whispered speech. If, therefore, we can provide a volume range of 70 db. (e.g., 10,000,000 to 1 in power), we can, by operating the volume control of the reproducer between individual items, obtain the required optimum result. Unfortunately, we cannot obtain even this range from most modern methods, and we have to be content with a volume range in the neighbourhood of 40 to 50 db. (or 10,000 to 1 in power).

The third important consideration is the ratio of signal to background noise which will be obtained from the reproduced record. The background is obviously important at low volumes, and it does in fact fix the value for the lowest volume which can be recorded. It is theoretically desirable to keep the noise level 30 db. below the lowest signal level, but this would leave us with practically no effective volume range, and so in practice we consider the lowest signal level to be equal to the noise level.

Signal-to-noise Ratio

As we can obtain a measure of the physical track modulation corresponding to this noise level, and also we can fix a limit to the maximum permissible modulation for any recording system, we have an exact measure of the total volume range available.

In addition to and combined with the three considerations enumerated above, various types of distortion can occur. These are phase distortion, amplitude distortion, and the introduction of spurious harmonics by modification of the wave form. These items will be discussed as they arise in descriptions of various methods.

The general principles of the photographic sound record upon a talking film are probably well known to readers of this journal, but it may be as well to review them briefly before considering more technical details.

The sound track at the side of the picture occupies a total width of $\frac{1}{10}$th of an inch on the film, but the actual width modulated is only 0.070 of an inch in variable area records. Two distinct forms of record are possible, and these are known as "variable area" and "variable density" respectively. A combination can also be used.

The variable area form is the easier to understand, because it is well known that any sound may be represented by a complex sine wave of the sound pressure waves plotted to a time base.

This is actually what is done, but a single line tracing the wave form is not sufficient, for we can only reproduce our record by shining light through it, and a constant width line, no matter what complex shade it traced out, would not change the amount of light which passed through the film. To overcome this difficulty the area on one side of the curve is made completely black and the area on the other side remains clear.

This form of sound record in the simplest case is made by exposing the film as it is drawn past an aperture of breadth equal to the sound track required and having a width in the direction of the film travel small in comparison with the wavelength of the highest frequency which it is required to record. This aperture is illuminated on the side remote from the film by a patch of light, which, by electromagnetic means, can be caused to traverse the breadth of the aperture. Thus in the equilibrium position of the system, when no sound is being recorded, this patch of light is stationary and covers exactly one-half of the breadth of the aperture, but when sound is recorded the beam of light may, on one half-cycle of sound pressure, move to cover the whole aperture, and on the next half-cycle the aperture will be emptied.

Variable Intensity of Illumination

The variable density form of track is produced in a very similar manner and is reproduced in exactly the same way. In fact, the two forms of recording are reproduced by the same equipment without change. In the production of a variable-density record in its simplest form the film is again propelled past a stationary aperture, but in this case the length of the illuminated portion is not changed, but rather is the aperture illuminated throughout its length and the intensity of the illumination changed proportionally to the volume of the sound to be recorded and at the same frequency.

By this means is obtained a track in which, with no modulation, the transmission over the whole width is proportional to the mean of the maximum and minimum intensities of the recording light beam. When the system is modulated the track over its whole width becomes alternately more dense on the positive half-cycles and less dense on the negative. In effect, the sound photograph appears to have a series of striations running at right-angles and to the full width of the track. The density of these striations at any point is a measure of the volume level recorded,

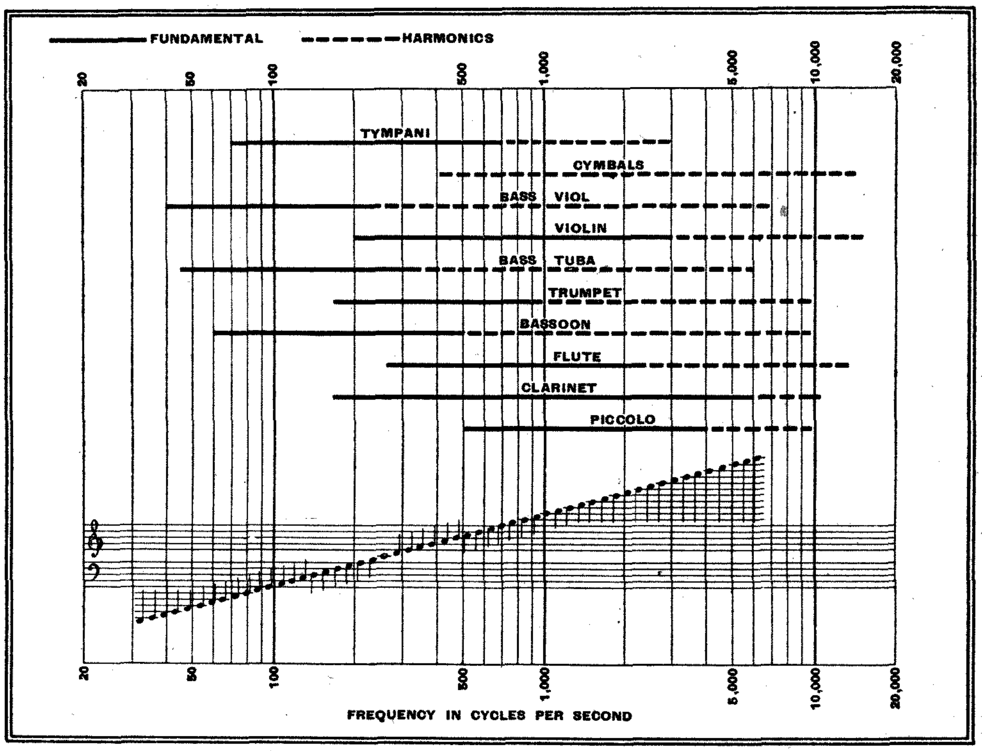


Fig. 2.—Fundamental and harmonic ranges of various musical instruments.

while the distance apart of successive striations is a measure of the frequency.

In all but news-reel work the original sound and picture records are made on separate films, these individual negatives being afterwards exposed in contact with a third film to form the combined positive. The use of these two negatives is partly for mechanical convenience, but more particularly because the photographically fast stock required for the picture camera entails a coarse emulsion structure which is quite unsuitable to record the fine definition required for the higher sound frequencies. Thus a slower emulsion is used in the sound camera, which is electrically interlocked with the picture camera to ensure synchronism.

The amplified electrical energy from the microphone is fed, *via* the amplifier channel, to the device controlling the exposure of the sound camera. For variable-area recording this is usually in the form of a mirror galvanometer.

In its most simple form a loop of fine wire carrying the speech current is suspended in the plane of a magnetic field. A small mirror cemented to the centre of the loop completes a mechanical system rotating about an axis through the plane of the mirror. In more complex apparatus the primary mechanical system carrying

Sound Recording—
a larger mirror is coupled to a magnetically controlled armature. The object of this elaboration is to make possible the use of a larger mirror and so increase the optical efficiency.

For modulating a variable-density recording system many forms of gas discharge lamp have been proposed, but the majority of commercial work is done by means of an electro-magnetic shutter device known as a light valve. A length of flat metal ribbon is formed into a loop with adjacent edges of the strip separated by about 0.002 inch. This loop is suspended in a magnetic field in such a way that when speech current is passed through the loop the aperture formed by the edges of the strip opens and closes on alternate half cycles.

Wide Frequency Range

Any of these modulating systems must be capable of giving an exposure proportional to the amplitude of the applied speech current over a frequency range of 20 cycles to 10,000 cycles per second.

For 35 mm. recording the rate of film travel is 18 inches per second, and so the maximum linear space occupied by one cycle at 10,000 cycles per second is 1.8 thousandths of an inch. This means that the width of the recording light beam in the direction of film travel must be small compared with the half-wavelength, or 0.0009 inch, because when the two figures are equal the modulation at 10,000 cycles becomes zero. The beam width used is of the order of 0.0005 inch, and this is obtained in the form of an optically reduced image of a larger aperture. Even this small slit causes an attenuation as the frequency increases, as shown in Fig. 3.

The mechanics of the recording camera must be carefully considered to provide constancy of film motion, and in good modern apparatus the film speed of nominally 18 inches per second is controlled to within 0.0001 inch at any instant. This problem needs a somewhat complex mechanical arrangement for its solution because of the physical nature of the film to be propelled, and this fact alone will always prevent the development of any very cheap film-driving mechanism.

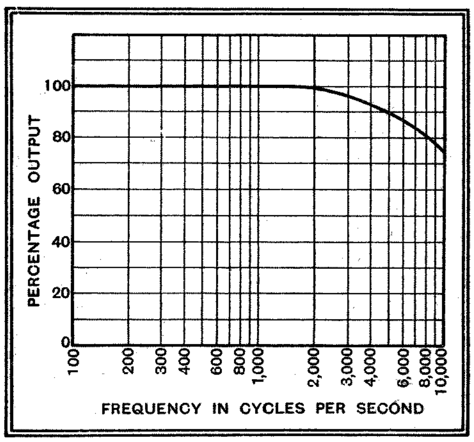


Fig. 3.—Attenuation of higher frequencies due to recording beam-width.

The chemical and physical properties of the film and emulsion affecting the sound recording are matters which have required a very considerable amount of attention, and improvements in these directions are still taking place.

The resolving power of the photographic emulsion can be simply stated, as its ability to record fine definition and its importance can be shown as follows.

It has already been explained that at normal recording speed of 18 inches per second for 35-mm. film, the wavelength of a 10,000-cycle tone is less than 2 mils. Thinking of a half-wavelength, its maximum width is 9/10,000 of an inch. This must be clearly defined with its peak tapering to a point of negligible dimensions, and, what is even more difficult, the valley between successive cycles must be sharply defined and free from fog. The actual resolving power of the emulsion is determined by the size of individual emulsion grains, which are the smallest exposable units, and also the slight scatter which takes place in the emulsion and which has the effect of exposing emulsion grains outside the boundary of the required wave shape.

To obtain the maximum volume range and minimum background noise from the photographed track it is necessary to

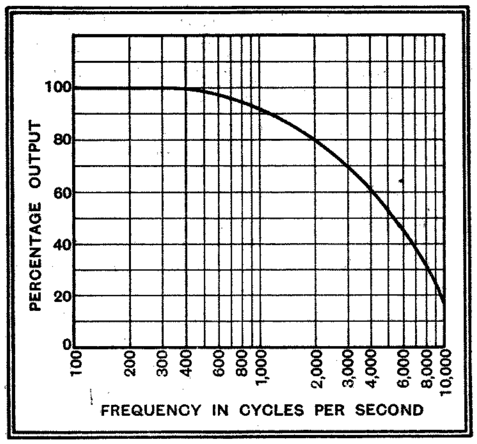


Fig. 4.—Attenuation due to lack of resolving power in the film.

achieve a density on the dark side of variable-area recording of 1.2 to 1.6, whilst maintaining the clear side absolutely clear. This is exceedingly difficult owing to stray light in the recording optical system and imperfect definition of the recording edge.

The positive prints for reproduction made from the original negatives must maintain this same standard in all particulars, and great care has to be taken in the mechanics of the printing machine to ensure that no distortion of the wave-shape is introduced by imperfect propulsion of the two films.

Variable-density recording has the same and also its own particular difficulties owing to the necessity for maintaining its range of exposures on the linear portion of the emulsion exposure-density curve.

The attenuation of the higher frequencies due to lack of resolving power is shown for an average negative record in Fig. 4. A further attenuation, of course, occurs when a print is made.

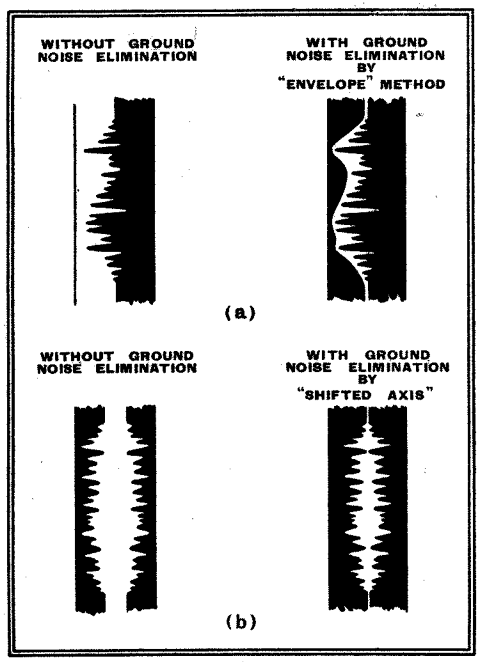


Fig. 5.—Methods of noise elimination with two forms of variable-area track.

A simple track made in either of the forms described will have a high noise level, due to the fact that the reducible substance in photographic emulsion is silver nitrate, in the form of grains of determinate size. This granular structure has the effect of modulating the excitation light in the reproducer to produce a background hiss. In addition, noise is produced by the dirt and scratches collected by the film during its useful life, and a third source is the "shot effect" in the photo-electric cell, which in amount is approximately proportional to the light flux on the cell.

It is evident that an unmodulated form of a variable-area track need not consist of two bands of equal width, one clear and the other dense, with modulation taking place about their dividing line. It can equally well take the form of a track which is dense over its whole width during unmodulated passages, providing that it is arranged that the track assumes its normal form for full amplitude signals and that correct relative widths are arranged for all intervening depths of modulation. A second condition is that the rate of change of the mean density shall always remain below the minimum rate of change of track density which can be audibly reproduced. In other words, the slope of the line representing this change of mean density shall always be less than the slope of the wavefront of the lowest frequency to be reproduced (usually about 30 cycles per second).

Anti-noise Measures

It will readily be seen that if this arrangement of track is adopted there will be no clear side of the track during silent intervals, and at any other instant there will be only sufficient clear track to accommodate the depth of modulation at that instant; the one change will thus almost completely eliminate both sources

Sound Recording—
of background. In the silent and quiet passages there is no (or very little) clear track which can give rise to background, and at the same time the mean light on the cell will be reduced in the same ratio and cell hiss will be minimised. A track of this form is shown in Fig. 5*a*.

Another form of variable-area track is known as the bi-lateral, and this enables ground noise elimination to be used with a rather more simple mechanical arrangement than that required for the added envelope method described above. In this case the recording galvanometer can be turned through 90 deg. with respect to the mechanical slit and a triangular aperture used in the light source in place of a rectangle. The galvanometer is biased at zero modulation to bring the apex of the beam down to the mechanical slit. It will be seen that a track recorded in this way consists of two symmetrical records placed one on each side of the centre line (Fig. 5*b*). During quiet passages the whole track area is black and the axes of the two wave-forms almost coincide in the centre. As modulation increases these axes move outwards to positions, respectively one-quarter and three-quarters across the width of the track by the operation of a rectifier circuit which lowers the galvanometer bias as the amplitude increases.

If we now make a summation of the

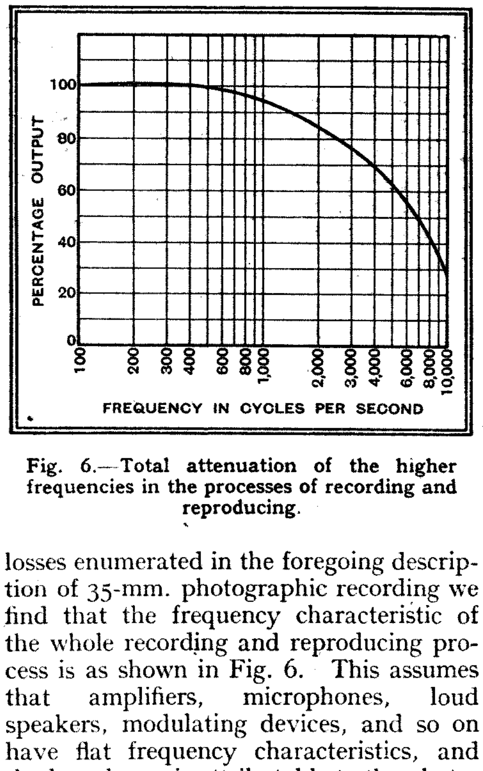


Fig. 6.—Total attenuation of the higher frequencies in the processes of recording and reproducing.

losses enumerated in the foregoing description of 35-mm. photographic recording we find that the frequency characteristic of the whole recording and reproducing process is as shown in Fig. 6. This assumes that amplifiers, microphones, loud speakers, modulating devices, and so on have flat frequency characteristics, and the loss shown is attributable to the photographic processes and the recording and reproducing scanning systems inseparable from the process.

Assuming minimum signal-to-noise ratio to be 1 to 1, as previously defined, by the use of ground noise reduction methods the volume range available from the final print is of the order of 50 db. Various specialised methods have been proposed for extending this figure, and at the present time there is considerable interest being shown in "volume expansion," in which the volume from the reproducer is made to increase out of direct proportion to the increase of volume on the record. This system, used in conjunction with an inverse method of volume-compression during the recording, may prove a valuable means for obtaining an overall volume range approaching the ideal of 70 db.

(To be concluded.)

What is a Wireless Engineer?

Importance of the Question Recognised

OUR Leader on the above subject, which appeared in the issue of November 13th, has had the gratifying result of stimulating comment on the question from various authorities. Below we publish a statement which undoubtedly does much to clarify the position, and other views are expressed in the correspondence columns of this issue. It is important to observe, also, that Dr. E. Mallet, in his Chairman's address to the Wireless Section of the Institution of Electrical Engineers on November 18th, dealt with the same problem. Dr. Hughes' contribution, published below, was received some days before Dr. Mallet's address was given, and the views expressed largely coincide.

Much of the blame for the present state of affairs, we observe, is laid at the door of the manufacturer, who is considered to be taking a short-sighted view of the position and not offering worth-while jobs to trained men, nor pursuing a policy of building up a technical staff on the firm basis adopted in other industries.

The whole subject is one which demands most careful investigation, and the interest which is at present being shown in the matter is extremely encouraging to those who have so long wished to see the status of the Wireless Engineer defined.

THE short answer to the pointed question in a recent Editorial—Why is there a lack of competent wireless engineers and what steps are to be taken to regularise their qualifications?—is that this dearth will continue until the radio industry thinks it worth while to attract men of adequate intellectual attainments, rather than to demand that its recruits shall be of immediate value as a result of over-specialisation.

A more full explanation takes us into the meaning of education and training and the realisation that the two are fundamentally opposed; in practice they can be made to overlap somewhat, with the result that their basic natures are confused.

By education we mean that development of innate ability and intellectual flexibility which enables the individual to live on terms of freedom with his fellow men.

BY L. E. C. HUGHES, Ph.D., A.M.I.E.E.

Dr. Hughes assists in conducting the Degree and Advanced Courses in Electrical Communication at the City and Guilds Engineering College and gives the results of some years' experience.

Psychologists divide thinking into factual and pleasure, the former denoting the capacity to infer inevitable deductions and inductions from observed facts, the latter to build on facts such cultural values which are socially useful. The former includes scientific activities and statistical data of all kinds, the latter politics, art, religion, and other cultural ideas which are not supported by facts, but arise from the inner motives and desires of men. Education, which ingrains these distinctions, implants the broadest outlook in the individual, guards him from being misled by plausible ideas thrust on him by others acting from self-interest, and gives him some backing for permitting the social uses of natural and technical resources (*e.g.*, in modern warfare). The educated man is one who can be relied on to make sound judgments, taking all relevant considerations into account.

By training we mean the acquisition of mental and manual procedures along predetermined lines which can be relied on to function with regularity when required. A high degree of training means increased attention to a narrower and narrower field of activity, with the normal exclusion of attention to other fields, since human capacity is more or less limited.

Of the three important divisions of human activity, work, civics, and play, education emphasises the latter pair, while training ignores them. The great feature of modern education, if we read the recent Board of Education Annual Report aright, is to hold a balance between all three which is more in keeping with the needs of the modern world, and biased to suit the needs of the individual more closely than was attempted in the last century. The facilities for the rising generation to specialise and despecialise and correct their outlook and usefulness as they develop are greater now than at any previous time, and with prevailing foresight and unless we lose our freedom this is certain to continue.

What is a Wireless Engineer?—

Before these ideas can be applied to recruits to radio engineering it is pertinent to define our field, not only of radio but of engineering. It cannot be denied that the field of radio is a very specialised section of electrical communication, which is one of the two definite halves of electrical engineering. The amount of strictly radio engineering that is used in any radio engineering work is again a small fraction. Consider, for example, microphones, loudspeakers, sound measurements, landlines, masts, power plant and rectifiers, filters, the whole business of manufacture of transmitters and receivers, none of which has anything to do with the propagation of electro-magnetic waves or the control of the currents associated with them. At the same time the above-mentioned items are important in other fields of activity such as telephones, sound-films, civil engineering, electrical supply and the whole art and science of mass production. To be an engineer, specialisation is desirable to a moderate extent only; he will be the more valuable in his work the more he appreciates the introduction of ideas from other fields of knowledge and activity into solving the problems he has in hand. Real specialisation is for the scientist in the laboratory, untroubled by costs and the necessity of getting a job done.

An engineer is strictly an individual who can be relied on to make, and be responsible to his untechnical employers for, major technical decisions. When he is merely carrying out instructions, however complicated, but without freedom to make decisions, he is not acting as an engineer, whatever the popular idea of an engineer may be. At a recent discussion of the subject at a meeting of the Wireless Section of the Institution of Electrical Engineers it was pointed out that practically no one in the room had been trained as a radio engineer, and yet it was suggested that the hall-mark of a radio engineer was at least his acceptance by the Institution into this section. Such is the opinion of the leading body of radio engineers who substantially control the industry; it is difficult to depart from it on fundamental grounds.

Over-specialisation

The claim is now put forward that radio is grown sufficiently to become a separate branch of the electrical industry and that it should set up its own standards of engineering status regardless of other branches of the electrical industry. The answer is that such a procedure would be the biggest dis-service to the radio industry that could be imagined. The large radio firms who manufacture radio apparatus other than broadcast receivers (and these can be counted on one hand), the Post Office, the B.B.C., the Services, and the cable companies all know quite well that the type of men they want and who are destined to take the responsible positions in ten and twenty years' time are those who have been thoroughly trained in the fundamental principles of applied science; they do not require that they shall be of much direct use for a number of years, but they are willing to invest in such men on the basis of their educational achievements and personality. Such men will be adaptable to changing conditions, and what they do not know for the use of their organisation they can be relied on to find out without much cost or delay.

The broadcast receiver industry stands apart. It expects to take trained men from college and expects them to solve its problems in time for the next radio show. It has been living from hand to mouth, technically, for the last decade, without building up any sort of engineering background for the future, and now when there are so many other lucrative avenues for adequately trained engineers to take after their formal and regulated education it is feeling the pinch and is apprehensive of its brains in the future.

Briefly, one does not train radio engineers at all. At the City and Guilds College, where, on paper at least, we conduct the most comprehensive Electrical Communication course in the country, only one of the four final degree papers concerned with Electrical Communication deals with Radio, which amounts, in fact, to roughly 6 per cent. of the total degree marks. This is a result of many years' experience, and it is unlikely that the proportion will be increased. Of the dozen or so students who take the Advanced Course in Electrical Communication and do some academic radio research only a few find their way into the broadcast receiver industry, other openings leading to more definite careers. If the industry considers its sources of recruits it will find a variety which is comparable with the outlets found by students who have been trained with a view to possible absorption in the radio industry. In fact, we teachers are very careful to refrain from assuming that students will take up any particular occupation, and any advice we give is based on the longest view we are justified in adopting and is directed to the best interest of the individual. From this point of view the broadcast industry does not appear in a good light; we teachers want to know what the student is to get out of his work and what value it will be to him in 5, 10 or 15 years' time, when he will be the indispensable engineer willing to accept major responsibilities.

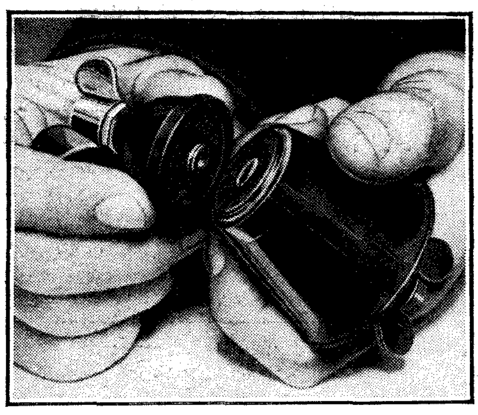
The output of the colleges in radio engineers *per se* is therefore not impressive in numbers, and the industry is seeking other methods of obtaining new trainees. To set up their own schemes might be of immediate value, but without educationists of long experience and the support of the existing body of radio engineers, such arrangements are not likely to be of permanent value. The intermediate step of inaugurating a National Certificate in Radio Engineering seems to offer the prospect of a satisfactory solution, but the successful inception of this scheme resides solely in the acceptance by the professional body—here the Institution of Electrical Engineers—of the result obtained by candidates working under varied teachers in existing institutions when examined by these teachers, who will certainly not yield to pressure of the industry to do its work for it at considerable public expense.

The new Higher National Certificate in Radio, which is "internal" in that the teachers examine, or the existing Final City and Guilds Institute Certificate in Radio Communication, which is "external," that is, based on a common examination paper, are normally taken at the end of a long course of part-time study of at least five years, generally by students who, after a day of possibly uncongenial work, devote their whole leisure to study. Having obtained these hall-marks, are they radio engineers in terms of our definition?

Salary and Conditions

To get these certificates they have to take several subjects other than specifically radio, and although their specialised knowledge of radio is probably greater than students who take radio in their engineering degrees (also done by part-time evening study), it cannot be claimed that in the long run students trained for a specific vocation will necessarily be the technical leaders in their chosen profession in the future.

To be an engineer one has to exercise responsibility which is recognised by one's equals. To make it worth while for a good man to accept such responsibility in the radio field he must be offered a reasonable salary and freedom to do his work without too much worry. If the radio industry wants adequately trained brains it must pay for them in the open market. All other branches of engineering do it and find it profitable, but it is not too late for this latest branch of industry to learn to do likewise.



AFTER THE STORM. Although this Goltone lightning arrester was fractured when the aerial to which it was connected was struck by lightning the receiver was undamaged.

PUBLIC ADDRESS MANUAL

ALL who are concerned with the technical aspects of public address, whether in a trade or professional capacity, will find much to interest them in the Partridge PA Manual, by N. Partridge, B.Sc., A.M.I.E.E.

As a start the book gives full constructional details of two amplifiers. The first is a 12-watt three-stage model with push-pull transformer-coupled output and resistance coupling in the preceding stage. A special output transformer permits the accurate matching of varying numbers of speakers. The second amplifier is a 30-watt model which has already been mentioned in these columns; it employs a low-loading push-pull circuit, an arrangement which gives a large output at very low cost.

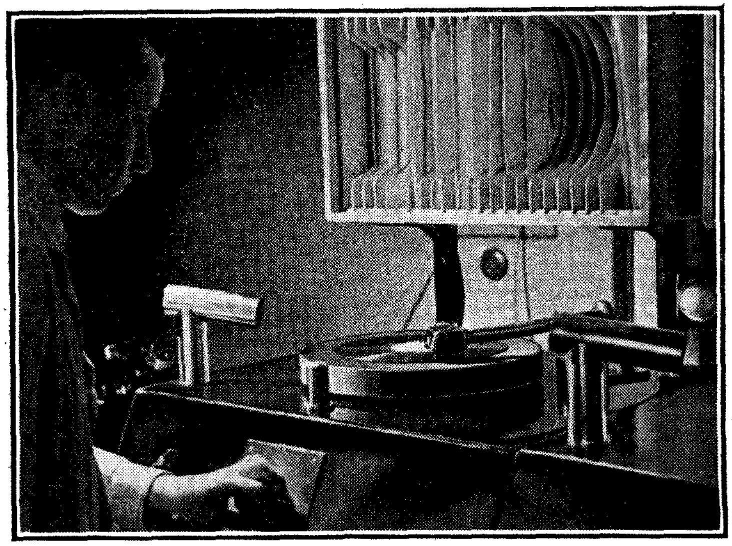
The advantages of pre-amplification are discussed, and single-stage and two-stage pre-amplifiers are described. The more ambitious model constitutes a complete control unit for PA work, providing for the independent operation of two microphones and two pick-ups, together with regulation of both bass and treble response. The associated subject of long inter-amplifier lines and the problems they introduce are dealt with at length, as is the question of speaker lines. Microphone technique, line technique, and intervalve couplings form the subject-matter of other chapters.

Copies of the book will be sent free to members of the trade who apply (mentioning *The Wireless World*), to N. Partridge, King's Buildings, Dean Stanley Street, London, S.W.1.

Recorded Interval Signals

NEW GERMAN SYSTEM—SOUND TRACK ON GLASS DISC

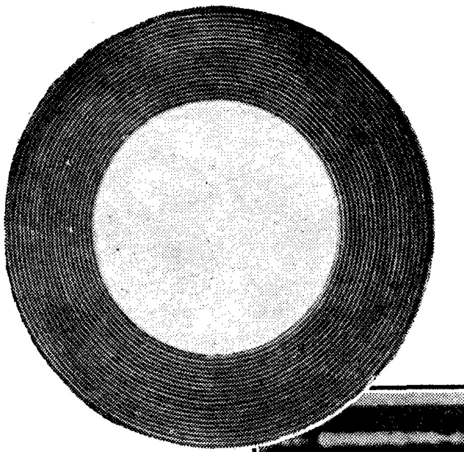
By Dr. H. J. von BRAUNMÜHL

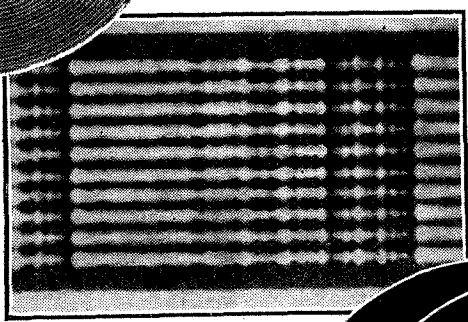


The gramophone record and standard pick-up system is used at Prague by the Czechoslovakian broadcasting authorities.

ALL sorts of devices have been used in the past for producing interval signals. Either they themselves generated the required sounds, which were then taken up by a microphone, or else they took the form of electro-mechanical devices such as mechanically struck steel bars or reeds, whose vibrations were picked up electromagnetically. In a few cases, gramophone records have been employed, as at Broadcasting House, Prague.

All these methods, except the last, have the disadvantage that only a limited number of effects are available, and each different effect means a change of apparatus ; and they all are subject to some more or less rapid deterioration or de-tuning which requires attention. Obviously, therefore, there was a need for an apparatus which would be free from these defects and would, moreover, allow the most varied types of signal to be interchanged at will—passages of music, chimes, speech, bird songs, and so on almost without limit, and all of the highest possible quality. For such an apparatus the use of some type of sound-recording process was clearly the only possible solution, and the special suitability of "sound-on-film" recording was obvious.

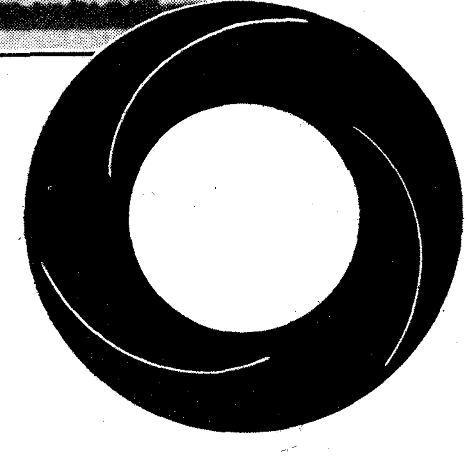




The German optical-record interval signal system. Above is seen the spiral sound track photographically recorded on a glass disc, and to the right a microscopic enlargement of a portion of it.

In the apparatus recently constructed for the German broadcasting service, however, the "sound-on-film" record is not made on the usual somewhat fragile film strip but on a circular glass plate the shape and size of an ordinary gramophone record. This transparent disc is sensitised like the usual photographic dry plate, and the interval signal is recorded on it in the form of a spiral sound track by ordinary sound-on-film technique. Any of the various recording systems can be used, but one of the recent versions of the "amplitude" process, the so-called "multiple jagged-edge track" process, has been found particularly satisfactory for this special purpose. As can be seen from the illustration of the microscopic enlargement of a short length of such a sound track, it consists of a number of parallel streaks each of which has been made to vary in width in rhythm with the sound vibrations. As the photograph shows, all the streaks are identical; together, they form the thickness of the line which runs spirally round the disc, like the engraved track on an ordinary gramophone record. The 12-inch record diameter is adhered to, and the standard record speed of 78 revs per min. is retained. Since quite a short playing time (10 to 20 seconds) is all that is required, the recording can be spread out so as to ensure really excellent high-note reproduction.

The slotted screen which slowly revolves under the recorded disc to give the radial scanning motion is seen below.



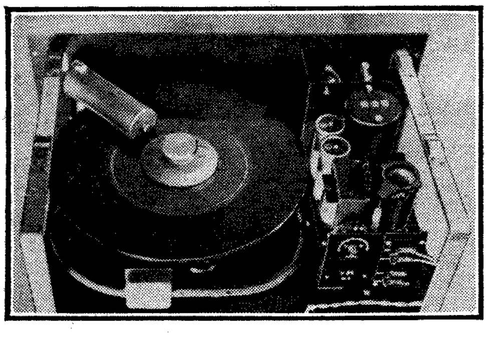
Advantages of the System

For reproducing such a record it is, of course, only necessary to scan it, as it rotates, by a narrow illuminated slit, so that the light ray, modulated in intensity by the varying total width of the transparent sound track, may fall on a photocell on the far side of the glass disc, and thus produce electrical variations corresponding to the recorded sounds. Ordinarily, the illuminated slit and the photocell would have to move slowly in a radial direction from the outer edge of the disc towards the centre, just as a gramophone pick-up swings gradually towards the spindle. But such a mechanical arrangement is replaced, in the new apparatus, by a much simpler optical device which is free from all mechanical trouble and deterioration. The narrow illuminated slit is made long enough to cover the whole radial width of the recorded part of the disc, but between the disc and the photocell is mounted a slowly revolving screen in which three short lengths of spiral slit have been cut. This revolving screen cuts off from the photocell all the strip of light coming through the glass record, ex-

Recorded Interval Signals—

cept for one spot corresponding to the thickness of the sound track; and by suitably proportioning the speed of the screen to the speed of the glass record it is arranged that one revolution of the screen gives three complete scannings of the record—one for each of the spiral slits—separated by three short intervals of silence. The screen is driven, through reduction gear giving, once and for all, the correct speed ratio between the two discs by the same synchronous motor which drives the glass record.

The view of the chassis reproduced shows the long reflector of the lamp, close to the revolving glass-disc record. A mains unit and pre-amplifier are included. The apparatus was employed for the first time at the 1936 Olympic Games, where



The apparatus as assembled for use. The spiral slits in the screen below the glass record are not discernible in this rather small reproduction of the gear.

a recording of a fanfare from an orchestra of wind instruments was used as the interval signal.

On the Short Waves

NOTES FROM A LISTENER'S LOG

AN interesting sunspot theory has just been advanced by F. E. Stowe in the Australian *Journal of the Institute of Engineers* (page 268, July, 1936).

Stowe suggests that sunlight is due to radiations from a radioactive solar "crust" entering the earth's atmosphere.

Sunspots are thought to be due to penetration of this "crust" by non-radioactive material.

It is also stated that a slight increase of temperature is produced on the earth while a sunspot is forming.

Nobody has, so far, however, given a really satisfactory answer to the other sunspot mystery, which is why does the number of sunspots increase to a maximum every 11 years, approximately? Although a study of the beautiful and well-known "butterfly-pattern" led probably to the establishment of Schirer's "Law of Zones."

The first spots of any new 11-year cycle always appear near the solar poles, and from then onwards successive spots increase in number and intensity until the maximum of the cycle is reached. By this time, however, the number of spots appearing in or near the polar regions has greatly diminished, and spots appearing after the maximum period tend to group nearer and nearer to the equator.

It often happens at the time of the sunspot minimum period that the beginning of a new 11-year cycle is heralded by the appearance of spots in high latitudes, whilst a few spots of the old cycle occasionally become visible in the equatorial region.

This sequence of events is now known to astronomers as Schirer's "Law of Zones," to which reference was made in an earlier paragraph.

Before leaving the question of sunspots a recent statement in *Science* suggests that there is no definite correlation between the weather and sunspots, and that the 53-, 5.7- and 2.8-year weather cycles are not connected with the 11-year solar cycle.

We seem at last finally to have changed into winter conditions, in fact rather abruptly so as far as Sunday, November 8th, was concerned.

Strangely enough, too, the phenomenon which was noted last winter—that is, good ultra-short-wave conditions in the afternoon often indicate poor conditions in the late evening—has again been experienced.

For example, at 4 p.m. the 28 Mc/s band was very active on this Sunday—stations like W1HFS and W1HQN peaking to R9 on the speaker—and also W2XE on 21.52 Mc/s was definitely good until close down at 6 p.m.

By 11 p.m., however, the only U.S. station audible was W1XAL on 6.04 Mc/s, and a deadly silence prevailed below 9 Mc/s. The Boston station W1XAL was really amazingly good, however, at R8/9, merit excellent.

The following night conditions were definitely better, and the U.S. broadcasters W3XAL, W2XAD and W8XK were all good, the latter remaining so until 10 p.m., at which time it still possessed adequate programme value.

Excellent results were again obtained from W1XAL on 6.04 Mc/s in the early hours of Tuesday and, indeed, it actually had a clear channel in the overcrowded 6 Mc/s band—a unique occurrence so far as the U.S. stations are concerned in this band.

Winter Conditions

There was again a tendency to winter conditions on Tuesday, November 10th, but W8XK again managed to hold his own on 15.21 Mc/s until nearly 11 p.m.—a remarkable performance for November.

The winter tendency became much more marked on Wednesday, which probably accounted for the excellent performance of PMN Bandoeng on 10.26 Mc/s during the afternoon; in fact this station has continued to give good results in the afternoon on this relatively low-frequency.

The best signals on Thursday, November 12th, were W2XAD, round about 7 p.m., and W2XAF at 12.30 a.m. (Friday)—both obtaining an excellent rating at the times mentioned.

Friday, the 13th, was characterised by low noise levels, even on 9 Mc/s—a fact which helped W1XK to put in a good appearance on 9.57 Mc/s at 9 p.m.

In the evening both W3XAL and W2XAD possessed considerable programme value, the latter being the stronger signal but closed down, as usual, at 8.45 p.m.

The Boston station W1XAL was best on 11.79 Mc/s on this occasion, with W8XK again performing well on 15.21 Mc/s until close down at 11 p.m. A weakish signal maintaining a good standard by virtue of a very low noise level—under which conditions a sensitive quiet receiver can be used to great advantage.

Conditions late on Saturday evening, November 14th, contrasted sharply again with the preceding day, practically no signals being audible above 10 Mc/s at 11 p.m.

Even W2XAD was very weak at 7 p.m., so weak in fact when compared with W3XAL, that it is possible the normal European beam aerial was not in use.

Ultra-short-wave conditions were again good on Sunday, November 15th, and at 5.30 p.m. I managed to hear one U.S. police transmitter on approximately 37 Mc/s (8m.), but was unable to catch the call-sign, owing to very deep fading. The signal was, however, peaking to R9.

W2XE was again very good on 21.52 Mc/s until close down at 6 p.m.

ETHACOMBER.

Book Review

Television Technical Terms and Definitions. —By E. J. G. Lewis. Pp. 95+14 for notes. Thirteen figs. Sir Isaac Pitman and Sons, Ltd., Parker Street, London, W.C.2. Price 5s.

A PERUSAL of this book brings home to one the extent to which television has developed and the wide range of sciences and arts that it embraces. Few of those who are now taking an interest in television have a grounding in all these subjects, or can spread their reading so widely as to keep abreast of all the rapid developments that are taking place. Here in one volume is easily accessible information for which one would otherwise have to search through vast numbers of books and papers.

Over 1,000 terms are explained, some of them in considerable detail; and there are thirteen diagrams illustrating the main principles of some of the more important devices used in television. In recognition of the rapid growth of the subject, fourteen extra pages are provided for alphabetical recording of new information.

Though the majority of the definitions are entirely helpful, a few are misleading or even quite wrong. A notable example is the so-called *Kerr Effect*, which is here not clearly distinguished from the *Faraday Effect*. The author has fallen into the common error of supposing the Kerr Cell to have a rotating effect on a beam of light, or rather its plane of polarisation; whereas it actually has the effect of elliptically polarising it. Moreover, this result is stated to be caused by an *electro-magnetic* force instead of *electric*.

The information on ultra-short wave aerials and on the super-regenerative receiver also is unsatisfactory; and the Scophony system deserves fuller and more up-to-date information than is provided. When a revised edition is required, these and a few other defects can be remedied. On the whole, however, the book is to be recommended as a guide to the technical terms now being used in the literature of television.

M. G. S.

CURRENT TOPICS

STATION DIRECTOR FOR TEN YEARS. Dr. Emile Notz has been with "Radio-Basle" since its foundation.

EVENTS OF THE WEEK IN BRIEF REVIEW

Indian Police Wireless

RADIO apparatus has been installed at police headquarters in Bombay and also at the Nagpara and Byculla police stations. These installations are operated in conjunction with two radio-equipped cars.

Anglo-German Licence Race

IT is expected that the number of German listeners will exceed those of this country by Christmastime. The latest figure, which was issued on November 1st, is 7,757,265. It is confidently anticipated that the eight-million mark will be passed some time in January.

New Tunis Station

THE French Government has announced its intention of providing a 100-kilowatt broadcasting station for Tunis at a cost of three million francs. The Tunisian Colonial Government will, however, be called upon to pay for the actual cost of installation. The running costs of the station also will be a charge on the local Government.

New Short-Wave Stations

IT has been decided by the Norwegian authorities to replace the Jeloy short-wave transmitter by a completely new installation having a power of 5 kW. It was originally decided merely to augment slightly the power of the existing station, and the decision to replace it by a new one of considerably greater output has been taken as the result of numerous requests received from listeners, many of whom are Norwegians resident abroad.

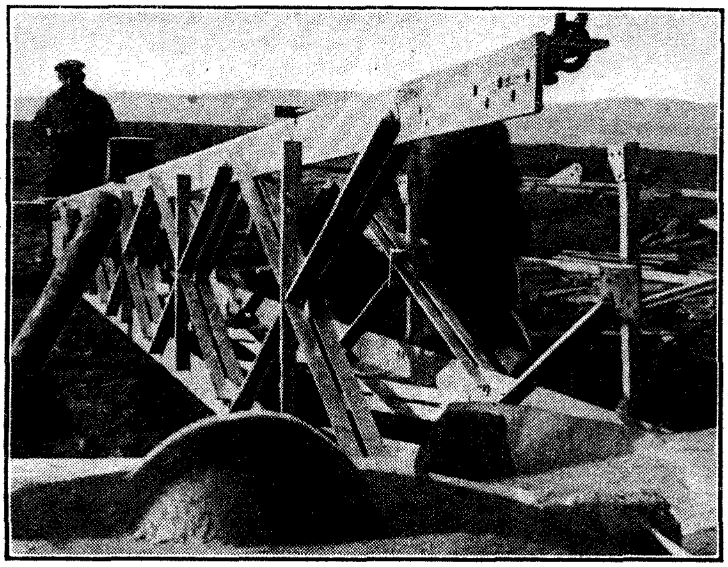
A Karachi firm has applied for permission to instal a short-wave transmitter in the city. This particular company has lately been carrying out a good deal of experimental work on the short waves. The transmitter which it is hoped to erect is of American design and is intended to work in the neighbourhood of 40 metres. It is hoped that it will provide a consistent service for the whole of the province of Sind.

Belgian Television

HITHERTO no great television activities have been reported from Belgium, but a definite move is being made and special premises for television have been set aside in the Brussels Radio House. An official delegation is now in Holland studying the television work being carried out in Dutch laboratories.

Lighthouse-Keepers Want Wireless

A CONGRESS of French lighthouse-keepers has passed a resolution asking that all lighthouses should be provided with a complete wireless transmitting and receiving installation in order that it may be possible to obtain assistance from the outside world in times of necessity.



RADIO-SOFIA IN THE MAKING. Work is now proceeding apace with the erection of a new 100 kW. transmitter in the Balkans. One of the 600ft. masts is seen in course of construction.

N.Z. Amateurs Lead the World

THERE are 950 amateur transmitters in New Zealand, this being one per 1,500 of the population. This percentage of amateur transmitters to the population is said to be by far the greatest in the world. Even the U.S.A., with its large number of transmitters, cannot approach anywhere near to this percentage figure.

Wireless in Mongolia

THE Japanese military authorities in Mongolia have just completed a very efficient chain of wireless stations round the border of their sphere of influence in Mongolia. By this means the approach of marauding bands can be instantly notified to headquarters and the necessary reinforcements rushed up.

U.S. Wireless Trade Improving

TRADE figures just made available show that wireless is booming in the U.S.A. The Radio Corporation of America had a net income of over a million dollars during the third quarter of 1936, this being nearly a half a million dollars more than for the corresponding period last year. The income for the first nine months of 1936 shows an increase of forty-six thousand dollars over the same period of 1935. By far the greater part of the increase occurred in the third quarter.

Pensions for Wireless Workers

A PENSION and life assurance scheme, established for the employees of the Marconi Co. at their Chelmsford works and elsewhere, has the rather unusual feature that if an employee leaves the service of the company he can, if he so desires, still continue his contributions and obtain a pension at the normal retiring age.

India's Regional Scheme

ACTING on the recommendations of Mr. H. L. Kirke, of the B.B.C., who some time ago outlined a scheme for the development of broadcasting in India, the Government has decided to establish eight new stations at a total cost of four million rupees.

The scheme provides for 1 kW medium-wave stations at Trichinopoly, Dacca, Lahore and a place, not yet chosen, in the United Provinces. 5 kW short-wave stations are to be erected in Calcutta and Delhi and, later, also at Bombay. Eventually Madras will also have a 5 kW station, although at present no decision has been made with regard to wavelength. A ¼ kW medium-wave station will also be installed at Peshawar.

An early start on these is likely to be made and already Mr. C. W. Goyder, the newly appointed Chief Engineer, is said to be taking the necessary steps to commence operations.

Television Figures

IN reply to a recent question asked in the House, the P.M.G. stated that the television plant acquired by the B.B.C. up to the end of October cost approximately £110,000. With regard to the total number of television viewers, the only method of ascertaining this was by the number of sets sold. The Television Advisory Committee had, therefore, approached the Radio Manufacturers' Association to arrange for them to supply from time to time confidential figures concerning their sales of receiving apparatus.

International Review of Broadcasting Problems

SEVERAL of the more momentous aspects of broadcasting are dealt with in the current issue of *Radiodiffusion*, the organ of the International Broadcasting Union. Arthur Burrows writes on "Broadcasting in the Cause of Peace," and Major Anderson on "Some Legal Aspects of Television." There are several articles of technical and semi-technical interest, including a description by Raymond Braillard, of the Observation Post at Brussels. The question "Should Radio Instruct or Amuse?" is debated at length.

Copies of *Radiodiffusion* may be bought from the B.B.C. Bookshop at 2s., or by post 2s. 3d.

UNBIASED

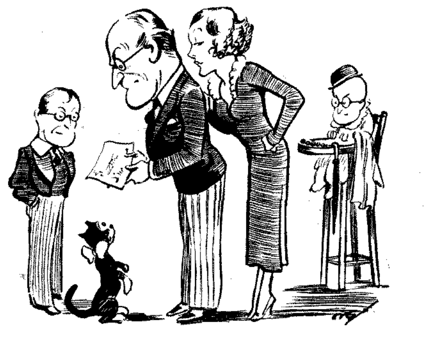
By FREE GRID

The eccentricity of their appearance.

Hush Money

IT is astonishing what a large number of people there are who are still under the impression that all the English programmes dished up by Continental stations for their benefit, more especially on Sundays, are first-hand instead of coming from gramophone records. I don't know what is the actual percentage which comes from records, but I rather fancy that if the truth were known it would be found that the figure would be as near a hundred as were the offensive portions of the curate's egg.

I must confess, however, that even I, accustomed as I am to the depravity of human nature, did not realise that the mechanising of these programmes was carried out as thoroughly as I have since found out to be the case, and I must congratulate those responsible for it, not, of course, for their depravity in taking advantage of the unsophisticated public, but for their ingenuity and thoroughness. Occasionally, as you know, these Continental stations break down for a few minutes, and after a brief interval of silence we get the same suave apology for a technical hitch



A substantial cheque.

as we do now and again in the case of the B.B.C. stations. I have always thought that a tame announcer—the same man who changes the records—was kept to do this odd job. To my amazement I have discovered that in the case of certain stations even this is all part of the programme. Even the records do not apparently have an attendant menial to change them, but are dealt with by an outsize in record changers.

My discovery of this state of affairs was due entirely to one of those odd turns of fate which, as some wretched poet once said, upsets some of the best-laid schemes of mice and men. I happened to be listening to one of these monotonous programmes one Sunday afternoon in order to settle an argument as to whether it was slightly more or slightly less soul-destroying than the B.B.C.'s Sabbath efforts, when suddenly the melancholy sounds which pass muster for music in these degenerate days ceased, and we were granted a few moments' peaceful relief. I was absolutely dumbfounded, however, to hear the needle scratch still merrily continuing in spite of the sudden cessation of other sounds, and it was not until long after the announcer's voice had given the conventional apology that I realised that there had, of course, been no breakdown at all. Seizing pen and paper, I forthwith indited an epistle to the publicity manager of the firm whose products were being advertised at the time and demanded an explanation, as I could see neither rhyme nor reason in the interpolation into the programme of an imaginary breakdown.

If I had been astonished at discovering this state of affairs, I was completely flabbergasted when I received by return of post a substantial cheque from the firm in question with an explanatory letter stating that this "breakdown" had been staged in order to impart a sense of genuineness for the benefit of the listening public whose faith in the first-handedness of the programmes had been rudely shaken by an unfortunate contretemps of the previous Sunday when the record of the announcer's voice had got stuck in a damaged groove.

The cheque was, I learnt, partly a gratuity to me for pointing out the fact of the continuance of needle scratch during the supposed breakdown period which would, of course, give the game away. The chief purpose of the cheque, however, was as hush money. Needless to say, I returned it forthwith, in spite of Mrs. Free Grid's protestations about new hats and suchlike dross, together with a strong letter. Although I notice the scratch has now been hushed, *I* certainly have not, and that is why I have given you the full facts herewith.

An Unjust Imposition

THROUGHOUT a long and somewhat adventurous life, in which I have received with equanimity many of the hard knocks of fate, I have always prided myself on being as public-spirited and as conscious of my duties to my fellow-citizens as the next man. Not even in the face of the base ingratitude which has sometimes been my lot have I faltered in my set course through life, but just lately an incident, or rather a series of them, has occurred which has, to say the least of it, somewhat shaken my faith in human nature.

As one of the few people possessing a completely up-to-date television receiver, I naturally considered it my duty to fling open wide my doors to my less fortunate fellow-creatures. I had, of course, expected the house to be rather uncomfortably filled during the television sessions, and my expectations in this respect were amply fulfilled. In reply to Mrs. Free Grid's protestations about the mud left on her best carpet by my visitors, I felt compelled to draw her attention to the reply which Julius Cæsar had made to Calpurnia on a somewhat analogous occasion. Women are notorious for having the last word, however, and her next complaint concerned the type of person which, she alleged, the demonstrations appeared to attract. I pointed out, however, that all geniuses and great men of science have been noted for the eccentricity of their appearance.

I greatly regret to say, however, that I was reluctantly forced to come round to Mrs. Free Grid's way of thinking as the result of certain regrettable incidents which took place. To put it bluntly, certain small and portable articles of value were missed from my home after these demonstrations. I was convinced, and still am, that this did not indicate any lack of honesty among my guests, but merely pointed to the fact that they had allowed their enthusiasm for television to lead them away into borrowing these articles so that they could raise the wherewithal to buy sets of their own. But, nevertheless, I could not afford this constant drain on my resources. Accordingly, I commenced to charge a small entrance fee, this being graduated daily according to the losses sustained on the previous day.

This arrangement worked quite smoothly for some little time, when a thunderbolt arrived on my breakfast table in the form of a peremptory demand from the local Revenue Inspector for a large sum in respect of Entertainment Tax. I naturally protested, and pointed out that the money I charged the public was in reality not an entrance fee, but merely a levy to pay for the tobacco, beer and other articles which certain of my guests were accustomed to borrow. To my surprise this has resulted in the arrival of a summons for selling tobacco and alcoholic liquor without a licence.

I regret to say, therefore, that I have been compelled, temporarily at any rate, to close down my demonstrations, nor can I comment upon the circumstances in the manner in which I should like to do, since the matter is, of course, *sub judice*.

Automatic Tuning Control

A Children's Hour Story

By "CATHODE RAY"

SOME years ago—round about 1928, I believe—a broadcast receiver* was put on the market which had, if my memory serves me well, six tuned circuits with separate knobs for the listener to get right. If it had not been that some guidance as to wavelength was given, and that each circuit was purposely rather flat, the chance of tuning-in any station at all would have been as remote as that of opening a 6-dial safe without knowing the combination — for mortals, limited to a lifetime of some threescore years and ten, *nil*.

Until the last few years even the most grandmotherly listener was expected to be able to adjust at least two tuning controls correctly, and not always with much help from the scales provided. Then "one-knob tuning" was advertised with the air of having reached the ultimate in simplicity and foolproofness.

But each simplification introduced by the manufacturer causes the unskilfulness (or laziness) of the public to take another step forward, so that the one never overtakes the other. The next difficulty was that people insisted on turning the tuning knob only long enough to obtain some sort of sound, so that what issued from the loud speaker consisted mainly of side-band shriek. The consumer (as we must now call him, for he has long since become too lazy actually to *listen* to the programmes) was then provided with a tuning indicator. Although the ears, through long debauchery, had become incapable of indicating when a station was correctly tuned, it was thought that the march of civilisation had not yet deprived people of the use of their sight; and all sorts of coloured lights, pointers, shadows, glass tubes, winking eyes and the like were devised for showing when the set was in tune.

Added Responsibilities

There was still an obvious flaw. Not only does a tuning indicator require that attention be given to the process of tuning, but it also demands the possession and application of appreciable intelligence. To leave no remaining excuse for getting less than the best of which the set is capable, manufacturers are realising that they are responsible for correctly tuned sets, not with the co-operation of, but in spite of, their customers. Everything about a set has to be automatic—automatic volume control, automatic tone compensation, automatic selectivity control; and surely automatic tuning control, too. Although it may appear that I have been taking a cynical view of the public intelligence and outlook, I do think it is quite reasonable that receivers for general use should require no unnecessary effort or skill, however small, for operating them properly.

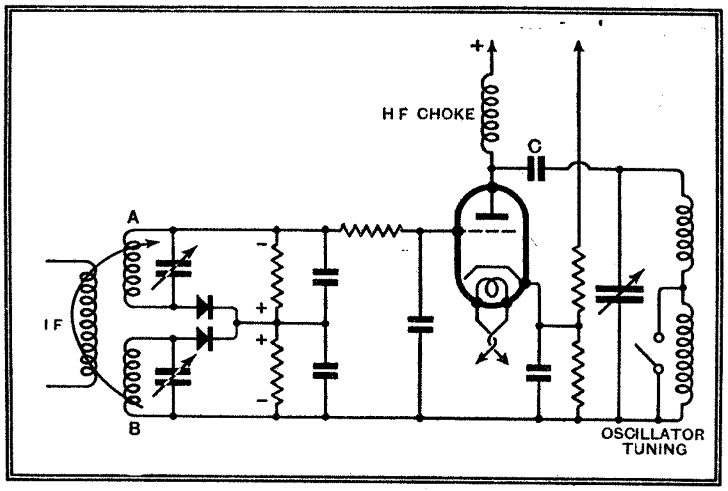
* The Marconi "Straight Eight."

The effect of automatic tuning is that as soon as the fringe of one station is reached the set takes charge, pulls the tuning into the correct middle position, and keeps it there until the tuning knob is turned so far as to get within the precincts of the next station. No matter how the user of the receiver may strive to do otherwise, there is always an expertly-tuned station or none at all.

This may seem very clever of the receiver; and so it is if it keeps on doing it without any visits from the service man. Unless the scheme has been soundly devised and carried out, an unfortunate possibility is that it may infallibly ensure the *incorrect* tuning of each and every station. How that may happen will be clearer when we have examined the method, or at least one of the methods.

We assume the superhet, in which the tuning *within the narrow band occupied by a station*—9 kilocycles per second—is controlled mainly by that of the oscillator, and only to a minor degree by the preselector circuits. If then a very small variable condenser C were connected in parallel with the oscillator section of the main tuning condenser of the set, it would be possible for a good fairy to control this small condenser in such a way as to neutralise the slipshod tuning of the owner. (It would also be possible for a small demon using the same device to ensure that, however skilful the owner might be, the set would always be slightly mistuned.)

Schematic circuit diagram of one system of automatic tuning control.



The fairy comprises two halves, each consisting of a highly efficient tuned circuit (litz, iron core, etc.) feeding a rectifier. One tuned circuit A resonates at, say, 4kc/sec. below the intermediate frequency and the other B an equal amount above. Both are coupled to an IF circuit somewhere near the point where the second detector is also coupled. The rectifiers may be diodes or metal rectifiers, and the output resistances of each are connected in series in such a way that the rectified voltage due to one opposes that due to the other. Filters are interposed to cut out the IF component of voltage.

The two resistances form part of the grid circuit of a valve. The impedance of the valve depends, of course, on its grid bias, and therefore on the signals applied to A and B. Suppose there are no signals. Then there are no rectified voltages, and the grid bias of the valve is confined to that which may be arranged by means of the usual cathode resistor shown, which is chosen so that the condenser C is in series with a medium impedance. It therefore exerts less than its full effect on the oscillator frequency, which is then just in line with everything else, as it would (or should) be in an ordinary superhet.

Now assume that a station happens to be correctly tuned in. The circuits A and B, being adjusted to equal amounts above and below the frequency of the IF signal, are equally responsive and give rise to equal and opposite grid biases. These cancel out, and things remain as they were.

But now suppose that the receiver is slightly off tune, say, tuned to several kc/s high. The signal is too low in frequency for it, and circuit A is much more responsive than circuit B. The grid bias of the

Automatic Tuning Control—

valve is made more negative, the impedance rises, the condenser C is therefore shut off from the oscillator circuit which now has less capacity and oscillates at a higher frequency, the frequency of the IF signal is thus raised and brought more nearly into tune. And vice versa throughout.

Although the tuning control by means of a valve in series with a condenser, as described, would work after a fashion, it is not the best method that has been devised; most practical ATC systems employ a rather more involved circuit in which, by feeding a signal to the grid of the control valve in different phase, an artificial capacity of controllable amount is introduced into the oscillator tuning circuit.

If the receiver is mistuned so much as to be clear of that station, neither tuned circuit is very responsive, and the fairy does not work. It is open to be affected by any other station that it *does* happen to be near.

When a fairy loses its balance, so that A and B are not equally spaced from IF, it turns into a demon, and from the loud speaker all is wailing and gnashing of teeth. So people with screwdrivers who attempt to improve on the makers' adjustments may be given advice in the classic words, "Don't do it!"

RANDOM RADIATIONS

By "DIALLIST"

A Television Suggestion

MORE than once the leading articles in the *Wireless World* have expressed regret that it should be found necessary to transmit by two quite different systems from the London Television Station. Both have already proved that they can provide reception of high entertainment value; then why continue this Siamese Twin experiment for two years? Here's an idea that occurred to me recently. A co-axial cable, all ready for television relays, has been installed between London and Birmingham. In the happiest event, as the Continental lottery circulars used to put it, it will take many months to build and install a new transmitting plant for Birmingham. London has two, either of which can fulfil all her needs. Then why should she "hog" both? Why not move one bodily to Birmingham? If this were done, the Midland television station could get under way pretty quickly.

The Aerial Question

NOT long ago I'd a word to say in these notes about people who handicapped good sets by using them with the poorest of indoor aerials. I've just been talking the matter over with a particularly live service man. He tells me that a very considerable proportion of his customers won't have outdoor aerials for one of two reasons or for both. The first is that they don't like the look of the mast and its halyards and wires; the second, that they jib at the expense of erecting the outdoor collector. There's probably a third reason, though he didn't mention it: not a few people are afraid of the outdoor aerial when thunder is about. It's quite unreasonable that they should be (I've found more than once that those who express such fears will ring you up on the telephone whilst the father and mother of a thunderstorm is raging overhead), but that's their feeling and there it is. In any event, we may take it as a solid fact that, for one reason or another, there's a very definite dislike of the outdoor aerial amongst ordinary listeners. Can anything be done to show them the error of their ways?

The N.B.C.'s Birthday Party

IT was good to hear "Uncle Arthur" Burrows speaking *via* the short waves from New York on the occasion of the National Broadcasting Company's tenth birthday. And some excellent jests he made: "Twenty years ago I was writing on wireless; and I was able to do so with authority, because nobody knew anything about it," is a good sample. Ah, happy writers of yesteryear! To-day, if one drops inadvertently the smallest and most ethereal of bricks the postman arrives with a sackful of more-in-sorrow-than-in-anger letters from expert readers—and they've all got to be answered!

The broadcast of the N.B.C.'s birthday celebrations was a huge success. I listened to it almost from start to finish, and reception from W2XAD was remarkably strong and clear. M. Jardillier, the French Minister of Posts and Telegraphs, was the first speaker, and very good he was. He was introduced as the only Broadcasting Chief who conducts his own orchestra, and probably he is. But our Sir John Reith must have been one of the first to give a variety turn over the wireless. I wonder how many readers can tell me what the turn was, and when he did it! No prize is offered.

Comparative Tests

ONE of the most interesting experiences I know is to test out two sets against one another, using the same aerial and earth and working with a switching lay-out that enables you to go almost instantly from one to the other. In no other way can you see so readily the advantages and disadvantages of different circuits and other internal arrangements. A two-way switch-over system presents no great difficulties; you silence the set that you don't want to be in action at the moment by turning the volume control to its "minimum" position and leaving the valve heaters still in action if it's a mains receiver. Then it's only a matter of a couple of seconds to go over from one set to the other, both being tuned to the same station. The differences between various AVC systems, particularly on the short waves, are quite remarkable. Just before this note was written, for example, I was making odious comparisons between two sets in this way, W2XAD being the test station. With one, fading of the rather quick kind was much in evidence, with the other it was a comparatively steady signal. On all wavebands any differences in sensitivity and selectivity are brought out to the full in the way suggested. It's surprising, too, to find that on one set a station may be clear of serious interference while with the other it is almost blotted out.

World Broadcasts

ONE very important part of the work of the International Broadcasting Union has been the fostering of better understanding and better relations between nations. They began their task by promoting the exchange, by wireless or wired link, of concerts between various countries. At first the difficulties were very great. In Europe there were few "land lines" that would carry satisfactorily the big range of frequencies needed for music. This obstacle has been overcome by the pertinacity of the I.B.U., and there is now so wide a network of compensated and balanced lines that concerts can be relayed between almost any part of the Continent and any other. But mere European concerts were not enough. The radio link has now been so developed by mutual co-operation that world programmes are possible. We and other European countries have already exchanged programmes with the United States. During the next twelve months the I.B.U.'s sphere will become much wider. We are to have, for instance, concerts from the Argentine and the Dutch East Indies.

The Spoken Word

Music speaks an international language that is more or less intelligible to all listeners. But music, great though its influence may be, cannot go quite as far as one would wish in bringing about mutual understandings between the nations of the world. The spoken word is infinitely more potent. Unfortunately, no speaker, no matter what language he may use, can establish direct and intelligible contact with more than a fraction of the possible audience for a world broadcast. The language difficulty has for a long time seemed almost unsurmountable. The I.B.U. have been working for years on the problem, and they seem now to have found a possible solution. In future a big and representative man in some country is going to speak to the world each month. Translations of his speech into their own languages will be sent in advance to the broadcasting authorities in all countries interested. When the time for the talk arrives we shall hear parts of it direct from the speaker, and then the translation will be read from our stations. That seems to me something really big in the world aspect of broadcasting.

CLUB NEWS

The Croydon Radio Society

An interesting lecture and demonstration on short-wave reception was recently given by Mr. H. L. Sulman at the Society's headquarters, St. Peter's Hall, Ledbury Road, South Croydon. Full details of the Society's activities can be obtained from Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

The Harco Radio Club

A radio club under the above title has been formed at Greenwich. Meetings are held every Thursday at 7.30 p.m., in the canteen lounge of G. A. Harvey and Co., Ltd., Woolwich Road, Charlton, S.E.7. The club has its own meeting rooms including a bar and also a car park. Trams No. 36, 38 and 40, and buses No. 53, 153 and 108 pass within a few yards. Morse instruction is given and the club is making arrangements to install its own transmitter and receiver. Intending members should get into touch with the Secretary at Department HRC, 124, River Way, Greenwich.

New Apparatus Reviewed

Recent Products of the Manufacturers

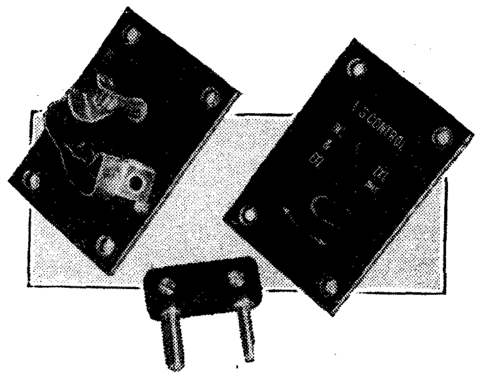
CLIX LS CONTROL PANEL

A USEFUL device for fitting to a receiver so that an external loud speaker may be used in conjunction with the internal one, or without it, or the internal loud speaker used alone, has been evolved by Lectro Linx, Ltd., 79a, Rochester Row, London, S.W.1.

It comprises a small socket panel in which a two-pin plug can be inserted, but, unlike the usual socket fitting, the plug can be turned a short distance to the left or to the right. One pin on the plug acts as the fulcrum about which the movement takes place.

Arranged behind this small panel is a set of contacts that open or close according to the position of the plug. They also close if the plug is withdrawn.

Thus by a slight alteration in the wiring of the receiver's loud speaker so as to include this switching device the various combinations of internal and external loud



Clix extension loud speaker fitting which embodies a switch.

speakers already mentioned become possible. The external loud speaker is connected to the two-pin plug. The price of this useful device is 1s.

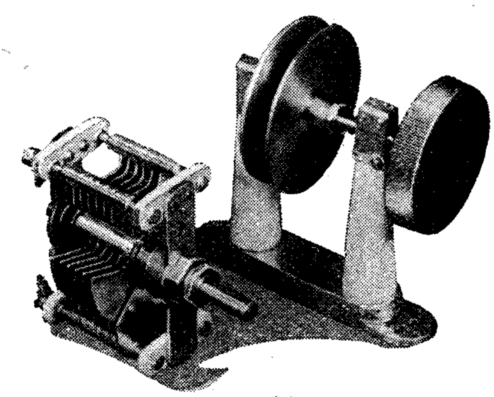
EDDYSTONE SHORT-WAVE CONDENSERS

THESE components, which are quite recent additions to the Eddystone range, are intended mainly for use in amateur transmitting apparatus, but as they are particularly well made and quite up to the standard of precision apparatus it will not be difficult to find many other uses for them.

The split stator condenser is in particular a most versatile component, as it provides the choice of three different maximum capacities, according to the way in which it is used.

Employed as a series-gap, or split stator condenser, its measured capacities are: minimum 3 m-mfds., and maximum 21 m-mfds. With a single section of the stator only in use it has capacities of 5 and 40 m-mfds. respectively. There was a small difference between the two sections, as the other side gave a minimum of 6 and a maximum of 41.5 m-mfds. Joining both stators together gives a condenser with a total capacity of 83.5 m-mfds. and a minimum of 11 m-mfds.

Both sets of fixed vanes are supported on Frequentite insulators, while the back bearing of the rotor is insulated from the brass cross-member, and contact is made to it by



Eddystone split stator and neutralising condensers.

a long enclosed pigtail. It is made of brass throughout, and all vanes are securely soldered. It is quite noiseless in use. The price is 12s. 6d.

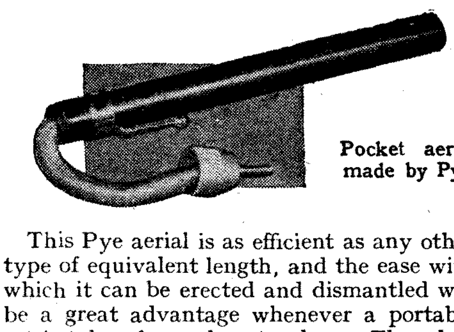
The other component is a small capacity condenser for neutralising RF power pentodes, or tetrodes, as used in short-wave transmitters. Two brass discs supported on insulating pillars form an air-spaced condenser with a capacity variation of from 2,6 to 12 m-mfds. One disc only is movable, and this is supported in a split bearing that is entirely free from backlash.

It costs 12s. 6d., and the makers are Stratton & Co., Ltd., Eddystone Works, Bromsgrove Street, Birmingham, 5.

PYE POCKET AERIAL

THIS aerial has been evolved for those who require something really portable and at the same time quickly and simply erected. It is, of course, equally suitable for a semi-permanent installation.

The aerial is a spiral of thin wire that is normally housed in an ebonite tube fitted with a screw-on cap to which is attached a split plug joined to one end of the aerial. It is anchored at the other end to the inside of the tube, and when fully extended will stretch to about 16ft. A clip for securing the tube to any convenient object is fitted.



Pocket aerial made by Pye.

This Pye aerial is as efficient as any other type of equivalent length, and the ease with which it can be erected and dismantled will be a great advantage whenever a portable set is taken from place to place. Though it has been opened out to its full extent several times the wire has always returned easily and accurately to its holder on releasing the tension.

This useful device is made by Pye Radio Ltd., Radio Works, Cambridge, and it costs 2s. 6d.

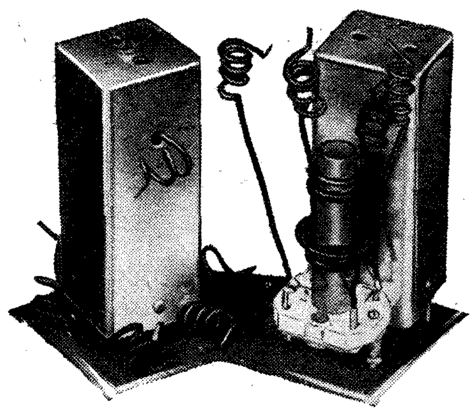
RAYMART VARIABLE SELECTIVITY IF TRANSFORMERS

MEANS for varying the selectivity, or band width, of the IF amplifier is a valuable feature in any superheterodyne receiver, as it enables high quality reproduction to be obtained from the local and other stations when the adjacent channels are not occupied by high-powered broadcasters.

High selectivity is also needed on the short waves, yet there are times when a wider band width could be tolerated with the advantage of improved quality in reproduction.

This variable feature is sometimes obtained by using transformers having one coil movable by a mechanical device, but it can also be achieved by an electrical change in the constants of the transformer.

The latter system is adopted in the Raymart IF Transformer Kit. This consists of two units, one a fixed-coupled pair for a frequency of 465 kc/s and the other a variable selectivity unit in which the band width can be changed from narrow to wide by a simple switching arrangement. This is effected by inserting a small coupling coil in series with the secondary circuit, but winding it over the primary coil. It is brought in, or removed from, the circuit by the switch.



Raymart Variable-selectivity IF kit.

Tests made with this kit show that the high-selectivity condition provides adequate sharpness of tuning for all normal requirements on the broadcast and short wavebands.

The low-selectivity position of the switch approximately doubles the frequency response of the IF amplifier and allows reproduction up to 10 kc/s off resonance without an appreciable reduction in the output. Of course, the overall selectivity of the set will be governed by the "goodness" of any RF stages that may be used, but our tests were concerned only with the IF units.

A point of interest regarding the variable-selectivity unit is that, in the low-selectivity position, the response band opened out symmetrically about the resonant frequency.

The design of these transformers is based on American practice. They are obtainable from the Raymart Manufacturing Co., 44, Holloway Head, Birmingham, and cost 15s. the pair.

South Africa Receives Alexandra Palace

ONCE again the seemingly impossible in radio has happened. We publish on this page a report from Mr. Pleass, of Johannesburg—in response to our cable—giving definite evidence of his reception (briefly reported in *The Morning Post* recently) of the sound transmissions from Alexandra Palace on 41.5 megacycles (6.67 metres).

It is true that carefully guarded statements issued by the B.B.C. have, quite rightly, stressed that the "guaranteed" service area of the television transmission would be limited to a circle having a radius of 25 miles from the Alexandra Palace, owing to the quasi-optical nature of direct ray transmissions on these high frequencies.

Only a few enthusiasts, however, seem to have envisaged that under suitable conditions and in certain directions indirect-ray propagation might be possible, and this latter possibility is now substantially proved.

Not only is indirect-ray transmission on 41.5 megacycles to Africa proved to be possible but *consistently* possible, more especially so when one remembers that a 7½-year-old three-valve straight receiver, without R.F. stages, and a 3 kW omni-directional transmitter are being used. True, we are still a long way from transmitting television pictures to South Africa, but all things must have a beginning.

The two greatest difficulties in the way of the establishment of an indirect-ray television service are, of course, fading and multiple-ray reception, the first causing synchronisation difficulties and the second ghost images (and possibly further synchronisation troubles).

The work of T. L. Eckersley, of the Marconi Company, on the transmission of high-speed facsimile pictures (first cousin to television) to Cape Town has shown, on the other hand, that results become progressively better as the carrier frequency is increased. It is also possible, of course, on these high frequencies to build arrays for both transmission and reception, which provide very large power gains and have very sharp diagrams on both vertical and horizontal planes. It would also appear to be a not insuperable difficulty to provide time bases which will maintain their stability during short fade periods.

Theoretical considerations show that Africa is very favourably placed for ultra-high-frequency reception from England during the noon and afternoon period, and, what is still more fascinating, it is also favourably placed for retransmission on the ultra-high frequencies to other parts of the Empire.

Therefore, looking firmly ahead with truly Wellsian courage, we see in South Africa a future centre of activity retransmitting scenes of daily events in the Empire's capital to members of the British Commonwealth of Nations in the remotest parts of the earth.

LOG OF RECEPTION

The Report is presented just as it was received from Mr. Pleass

YOUR cable of October 27th was duly received.

I note you ask for full "technical" story. There is none. I have simply adapted the "Pilot Wasp" receiver (0–V–2), battery model, with home-made coils to oscillate on the higher frequencies, in the neighbourhood of 56 Mc/s. The receiver in question was purchased locally about seven and a half years ago, and has, and is, serving me faithfully in my experimental work. Actually the coils supplied with the set covered wavelengths from 17 to 500 metres, but it was not at all a difficult matter to obtain oscillation at 28 Mc/s (10 metres). I have, in fact, worked all continents (WAC) on 10 metres. Having succeeded in getting good phone and CW signals on 10 metres I set about making coils in an endeavour to record CW on the 56 Mc/s (5 metres) band. This I achieved on April 29th, 1934—ZT6C (O. M. Owen) of this city put out a message on CW which I copied solid.

From the foregoing you will understand that having logged 5- and 10-metre signals it should not be difficult to intercept anything going on 7 metres.

A few weeks ago I began making coils to cover the latter frequency, and in the absence of a wavemeter had to rely on "harmonics" from commercial stations and local experimenters. Eventually I overheard music and a lady's voice saying: "Good morning, everybody; this is the B.B.C., Alexandra Palace, London." This was at 11.03 G.M.T. on October 13th, and the announcement was followed by talks on (1) Poems, (2) Dartboards—red elm wood being mentioned as suitable. In the description of the latter mention was made of the "divisions being corded with wire, circular and V-shaped. The scoring numbers being fixed by his (the constructor's) expert fingers in a minute and a half."

On October 15th I again listened about 12.00 G.M.T. and heard quite clear music, which apparently was used as a background as speech was heard also, reference being made to the Armada and Dutch War. Later a remark "about coolies loading ships—a mighty work dedicated to seamanship—over two million tons of fruit being imported—the docks at Southampton being framed in forty miles of railway—conveying express and goods trains," etc.

At 12.09 G.M.T. a lady spoke and mentioned "the Baird system and that the station was closing down until three o'clock for further transmission. Good-bye until then."

On October 20th I was listening on the 5-metre band and was astonished at the "harmonics" in evidence. CW signals were recorded at 14.42 G.M.T. "CQ DX de ZU6C" 20-metre fundamental. At 15.03 G.M.T. "CQ de ZU6P" (10-metre fundamental), and at 15.57 G.M.T. "CQ de ZS6D" (40-metre fundamental). The tit-bit of the afternoon was a call ZS2P de W.6 IRD at 15.40 G.M.T. (California on 5 metres!). I have received confirmation that the latter station was on 20 metres. Such signals can only come under the term "freaks," but it only goes to show what is going on around us.

On October 22nd at 11.38 G.M.T. the London Television sound transmitting station was again in evidence and an aeroplane flight was being broadcast. The announcer mentioned about the lovely hills and valleys being flown over, and mentioned San Francisco. Music was, as usual, in the background. At 11.58 G.M.T. a lady spoke about damsels and favourite smokes; also about "well-shaped shoulders before the winter is out." I could not follow this item too clearly owing to QSC. This was followed by a record of a championship fight with "the champion doing all the attacking." The shouts of the spectators could be clearly heard in the background. Mention was then made about a shipping disaster and that there was "no suggestion of a collision." Then followed an announcement that at Portsmouth the celebration had taken place of the greatest naval victory in history—with the H.M.S. Victory.

On October 23rd, at 15.15 G.M.T., Mr. Seymour Marks was introduced. A talk dealing with china ornaments—dragons, etc., was heard, this being from Leicester Square.

On October 26th, at 12.10 G.M.T., two piano solos were received. The sharp staccato notes of the piano were noticeably strong. Very little speech was recordable at this transmission. The "carrier" was erratic and appeared to be creeping and fluctuating, due possibly to conditions between the transmitter and receiving stations.

On October 27th speech was fairly clear, and mention was made about the highest mountain in the world. An aeroplane flight by the Royal Air Force, Karachi, over the Himalayas was described. Mention was also made regarding the weight of the machine; "40 lbs. under guarantee," "splendid," said one speaker. He mentioned "that the plane was still climbing and well above —." "The second stage of the flight now begins, and for the first time man is to look around on the face of the earth." "Yes," continued the speaker, "they must be pretty near it now—battling against adverse winds at one hundred miles per hour." What sounded like a propeller revolving was heard occasionally and a voice, muffled, shouting out orders, but I could not quite follow the remarks in this transmission.

At 11.50 G.M.T. the following remark was clearly heard, and was the best recorded by me to date: "Wales is supposed to have the prettiest milkmaids." "Do you agree with the judges?" The carrier continued until 12.09, but without modulation, and ceased at this time.

Conditions were unfavourable on October 28th and faint music only could be heard at 11.50 G.M.T. (My aerial was noisy—strong winds.)

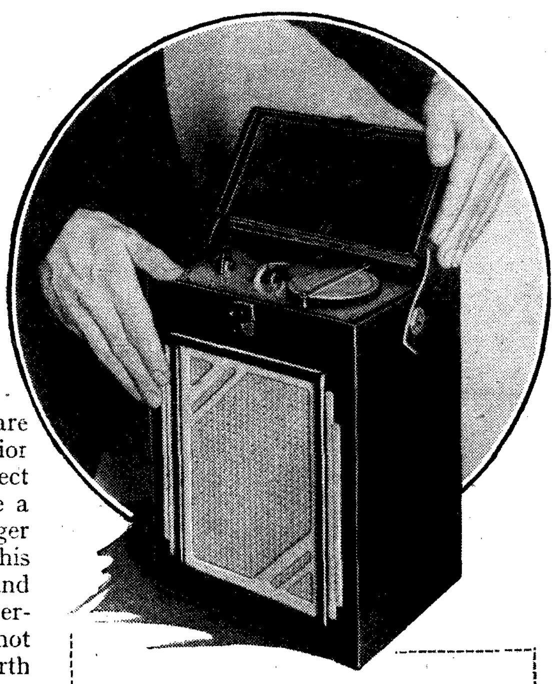
The foregoing, although not what can be called "technical," indicates more or less the items picked up on my Pilot Wasp.

I should esteem it a favour if you would convey the broadcasted items to the B.B.C. Alexandra Palace for their information. Thank you.

S. C. PLEASS (ZT6K),
"Pinecote," Bramley, Johannesburg.
October 29th, 1936.

Wayfarer Major Portable

A Four-valve Battery Receiver with Moving-coil Loud Speaker



FEATURES.—*Circuit.*—*Screened-grid RF amplifier—triode grid detector with reaction—triode AF amplifier—tetrode output valve.* **Controls.**—*(1) Tuning. (2) Volume (reaction). (3) Wave-range and on-off switch.* **Price.**—*7 guineas.* **Makers.**—*London Electric Appliances Ltd., 62, Glengall Road, Old Kent Road, London, S.E.15.*

THE original "Wayfarer" reviewed in this journal on October 11th, 1935, was a severely practical instrument with no great pretence to good looks. Its performance, however, was undoubtedly good, and it is gratifying to know that its salient technical features, with one or two notable additions, have been retained in the new Major model.

The set is housed in a well-proportioned cabinet of the "vertical" type, and the ornamentation of the loud speaker grille is both simple and effective. The controls are concealed under a lid on the top of the cabinet, and a lock has been provided, with an ingenious safety catch designed to prevent the removal of the back panel, to prevent unauthorised interference with any part of the set.

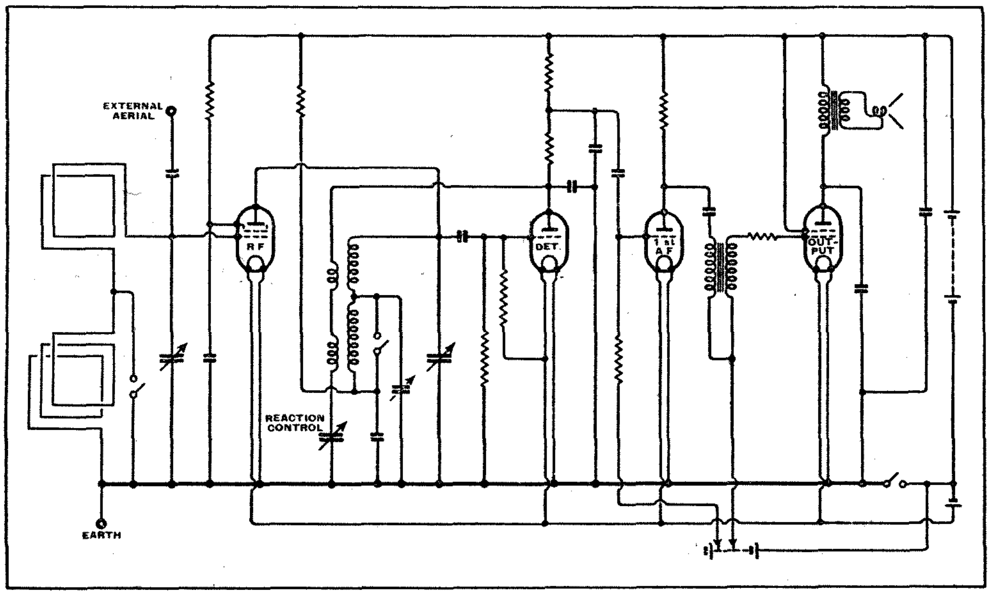
Instead of the independent solid dielectric tuning condensers operated by concentric controls used in the original model, there is an air dielectric two-gang condenser controlled by a 3-inch knurled disc which carries on its face the wavelength-calibrated scales and station names. This dial is bridged by a celluloid cursor which is very easy to read. The two remaining controls are volume (reaction) and the combined waverange and on-off switch.

The dimensions of the cabinet are appreciably larger than that of the Junior model, and this is not without its effect upon the performance of the set, since a frame aerial of correspondingly larger area is possible. The advantage of this is most apparent on the long waves, and on this range there is nothing in the performance to indicate that the set is not working on an outdoor aerial and earth system. In Central London stations such as Hilversum, Radio-Paris and Luxembourg were received at full strength with the volume control in the minimum position, and in the case of Droitwich use had to be made of the directional properties of the frame to prevent overloading of the output stage. With slight reaction the Air Ministry weather reports came in exceptionally clearly, and by rotating the set into the position of minimum signal strength from Droitwich the Deutschlandsender was satisfactorily received without having to call on critical adjustment of the reaction control. On the medium waveband the directional properties of the frame had once again to be called into use as a volume control in the case of the London Regional transmitter, but the National programme required slight reaction to bring the volume up to the level required for best results from the moving-coil loud speaker. One or two Continental stations were successfully tuned-in on the medium waveband during daylight, but for long-distance reception there is little doubt that the long waves provide the best results under daylight conditions.

The output with the HT voltage available is rated by the makers at 150 milliwatts, so that the volume must be kept at a moderate level if distortion is to be avoided. On certain types of transmission, however, a considerably higher volume level can be employed without audible evidence of overloading.

A Straightforward Circuit

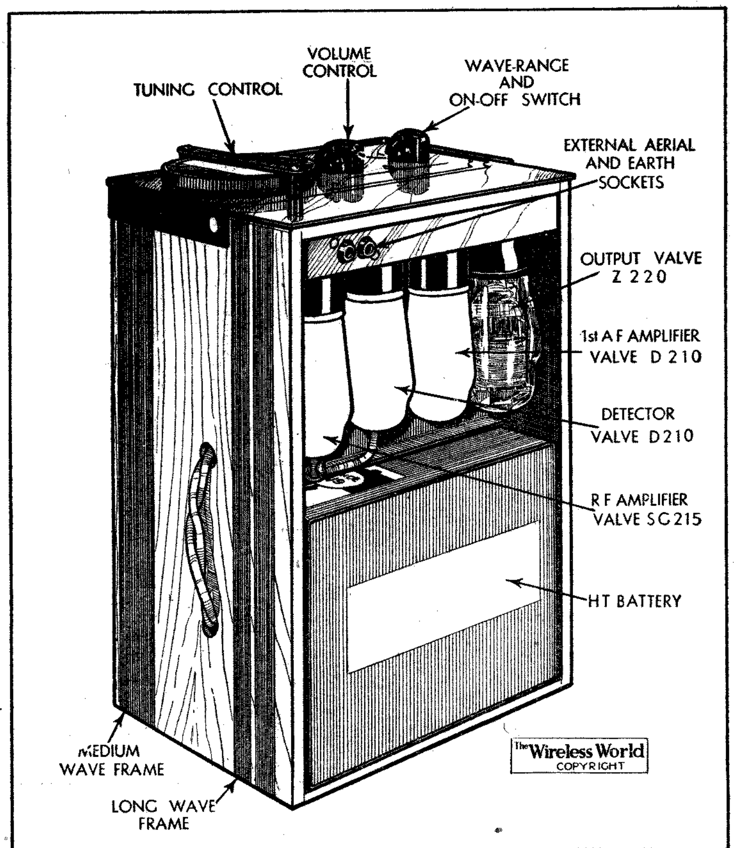
In its earlier stages the circuit follows closely the arrangement of the original "Wayfarer." A screened-grid RF amplifier with tuned anode coupling precedes a leaky grid triode rectifier. In the latter stage dual grid leaks are now provided to fix the mean grid potential at a point mid-way between positive and negative LT. Another alteration is to be found in the substitution of a resistance for the HF choke previously employed in the anode circuit. The first AF amplifier is a triode, resistance-coupled to the detector, and it is followed by parallel-fed transformer coupling to the output stage. The valve employed here is a tetrode, in which pentode characteristics have been achieved by critical spacing of the electrodes.



The circuit is notable for the use of a Harries tetrode valve in the output stage.

Wayfarer Major Portable—

It will be seen from the sketch of the chassis that the valves are inverted, but there is little chance of their being displaced as the valve-holder sockets maintain an exceptionally firm grip on the pins. The medium- and long-wave aerial windings are well separated, and the turns of the medium-wave coil are space-wound. To obtain access to the LT accumulator it is necessary first of all to remove the HT battery. In the particular model tested this battery was rather a tight fit in the case and some scheme might well have been adopted to facilitate withdrawal. The user is not, however, troubled with HT plugs and sockets as spring contacts are provided to connect with the terminal strips on the specially designed battery when this is pushed fully home. The HT battery, incidentally, is of standard capacity and has a rated voltage of 70.



Removal of the HT battery, which is provided with spring contacts, gives access to the LT and grid bias batteries.

The measured HT consumption with the makers' recommended bias for the output stage of -3 v. was 8.5 mA., but this was reduced to 6 mA. by increasing the bias to $-4\frac{1}{2}$ v. with a barely perceptible deterioration in quality at the optimum output level. The LT accumulator is a really useful size, having a capacity of 15 ampere-hours, and as the measured LT consumption was a fraction over 0.5 amp. the service on a single charge should be very little less than thirty hours.

The total weight of the set is only 14 lb., and the dimensions of the case are $12\frac{1}{4}$in. high, $8\frac{1}{2}$in. wide and $6\frac{3}{4}$in. deep. The leather cloth covering material is available in a choice of seven colours, the standard being black with cream loud-speaker fret.

Letters to the Editor

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

What is a Wireless Engineer ?

As one who has been concerned with the education and training of the wireless engineer and technician for the past fifteen years, I was interested in your recent editorial dealing with technical education and with your query, "What is a Wireless Engineer?"

It is, unfortunately, true that in the past there has been considerable confusion as to the necessary training and desirable qualifications for the radio engineer, and in particular for the radio service man. I think we may say to-day, however, that very excellent courses of training exist for all branches of the radio industry, not excepting radio service work, and that nationally recognised qualifications are obtainable, and as these do not seem to be generally known, you, Sir, and your readers may be interested in a brief outline.

For the young man who can afford the time and who has been educated to the School Certificate standard, the best proposition is to take a full-time course in telecommunications extending over a period of three years, in which time he is prepared for the National Diploma in Radio Engineering and/or for the B.Sc. degree in engineering. In the latter case he must have matriculated before entering on the course. The National Diploma is awarded by the Institution of Electrical Engineers in conjunction with the Board of Education, and the examination papers in all subjects at the end of the course, although set by the technical institution at which the student is receiving his training, are approved by external assessors, as is also the marking of the papers.

In this manner uniformity is secured throughout the country and the prospective employer is assured that the trainee has at least reached a definite minimum standard. In addition, the work done by the student in the laboratories is also taken into consideration, and here again a certain minimum mark must be obtained. Before starting a course of training the student should satisfy himself that the institution has been "approved" for the award of the National Diploma.

During his course of training the student should apply for student membership of the Institution of Electrical Engineers, and, after the necessary degree of practical experience has been obtained, for transfer to the higher grades.

In this connection it may be noted that both the National Diploma (provided the student can satisfy the assessors as to the required standard in English) and the University degree exempt from the graduateship examination of the Institution of Electrical Engineers.

The second course of training is concerned with the person who by reason of circumstances enters the radio industry on leaving school, or at some later time, and here he is catered for by an evening course necessitating an attendance of three evenings a week from September to April and extending over a period of four or five years. In this course the student may prepare for the National Certificate in Radio Engineering awarded by the same bodies and under similar conditions as for the National Diploma. He may also sit for the City and Guilds of London Institute examinations in radio communication, in which subject there are three grades, preliminary, intermediate and final, taken at the end of the second, third and fourth years respectively.

Here, again, it may be noted that the National Certificate (subject to satisfaction in English) exempts from part one, and the final examination of the City and Guilds from part two, of the graduateship examination of the Institution of Electrical Engineers.

The third course of training is concerned with the needs of the radio service man, and here it must be admitted that no generally recognised qualification has existed, although the institution with which I am connected, in co-operation with one of the largest radio manufacturers, has been catering for the requirements of the service engineer for the past five years and has issued its own certificate. It is hoped, however, that this will be remedied in the very near future and that the City and Guilds of London Institute, acting on the advice of a committee consisting of technicians and others in the radio industry, together with representatives of educational associations, will be able to formulate a syllabus of training for radio service work and to grant the issue of a certificate for such work. This course of training will necessitate an attendance of two evenings a week extending over a period of two or three years.

W. H. DATE,
Head of the Radio Section.

The Polytechnic,
London, W.1.

Looking at it from my own point of view, I have been engaged officially and commercially in wireless engineering for the last twenty-one years and I still do not know if I can conscientiously call myself a wireless engineer.

For some years I was able to put behind my name five letters which were calculated to bluff people into the belief that I knew what I was talking about so far as wireless was concerned, but it gradually dawned on me that these qualifying letters could be obtained by people who did *not* know what they were talking about and, having a conscience, I felt that I could not go on with it and, therefore, dropped them.

At the other extreme, there are two well-known institutions, both of which fall under your adjectival description, "die-hards," and, although it is some time ago since I made an attempt to fill up their application forms, I found that it was practically impossible for me to do so, one reason being the war years, for which it is difficult to obtain continuity. In one particular case, you may be surprised to learn that I ran round for a whole week in the evenings of summer days some years ago trying to get corporate members of one institution to propose and second me, but while I could get signatures underneath I could get nobody to take the risk of putting their name at the top.

There must be hundreds like myself who came out of the Army, Navy and Air Force, where they were trained or partly trained as wireless engineers, and entered the industry and have worked in it since, that, like me, have no qualifications of a standard available to other professions, which is a guarantee of their status.

Having worked, therefore, in wireless since I was twenty, I should like to be considered a wireless engineer before I die, so that if such a standard is set and agreed amongst the instructional bodies I should seriously consider taking the examination if it were in my power.

Staines, Middlesex. FRANK BOYCE.

MAY one quite individual answer be suggested? He is first of all a physicist, understands a little mathematics, something about crowd psychology, and, lastly, a man of practical experience in one or more definite branches of radio communication. Those with the final qualification are easily distinguishable, and they can, to a certain extent, look after themselves. The most that examination results can demonstrate is that the student is on sound lines and intends to devote his life (to use an Americanism) to the Radio Art; it is only fair to show him the right track. One supposes that those actively engaged in the industry know the type of man they need as an assistant; wish, in spite of keen competition, to make his remuneration sufficiently attractive, and progress themselves, leaving vacancies for the juniors. They will, therefore, fit themselves for higher posts. The success of the older-established engineering institutes has been partly due to the able administration of those who have given their time and experience unstintingly to the training of future generations. Those public-spirited wireless engineers who now come forward —as they will—to organise the professional personnel of the industry will not only be encouraging a much-needed reform, but will by example show that these are men worthy of high administrative posts in the ranks of radio engineers. Automatically they will be entitled to occupy those top positions to the exclusion of all other claimants, even, one dares to say, those of the sales department. It is our English way to do things slowly, almost to pretend that we are not doing them at all. I believe the work is going on, and we should be grateful for the acceleration. You, Sir, will give by your characteristically generous appreciation of the problem.

Ware, Herts. GERALD SAYERS.

Television Aerials

IN reply to Mr. Gordon Finlay's letter in your issue of November 13th, I must thank him for his discussion concerning the tendency for an inversion of equatorial polar characteristics of a horizontal dipole when presented to vertically polarised transmissions.

It is unfortunate, however, that the suggestion put forward by your correspondent does not account for the phenomenon.

The feeder used was a 75-ohm twin pair which we have specially developed for centre-fed dipoles. This feeder was terminated on a two-turn centre tapped coil and balanced to earth for any asymmetrical field.

To test for the accuracy of balance the aerial end of the feeder was disconnected from the aerial proper, and connected to a small 75-ohm Erie resistor, substantially non-inductive). In these circumstances the pick-up of either the vision or sound channel was negligible, and had the effect noted been due to any asymmetric behaviour on the part of the feeder, the voltage thus picked up would have been of sufficient magnitude to have been added directly to the normal polar pattern, and thus give the inverted pattern.

I believe that the effect is due to the formation of earth images, and in the case where the wave front is slightly tilted it will produce the effect we have noted.

I am working on this theory and will possibly be able to give the results in a further letter.

BELLING & LEE, LTD.
F. R. W. Stafford,
Chief Research Engineer.

Television Programmes

The principal items only of each day's programmes are given. The system to be used each day is given below the date. Transmission times are from 3-4 and 9-10 daily.

Vision 6.67 m. (45 Mc/s). Sound 7.23 m. (41.5 Mc/s).

FRIDAY, NOVEMBER 27th.
(Marconi-E.M.I.)

3.5, Two Animal Shows: Bird and Aquaria Show and Cat Club. **3.25,** Movietone Magic Carpets: "Diamonds in the Rough." **3.40,** Draper and Shires: exponents of the dance.

9.5, Two Animal Shows. **9.25,** Movietone Magic Carpets: "Happy Days in the Tyrol." **9.40,** Geraldine and Joe: juvenile dancers, and Van Deck: comedy quick-fire cartoonist.

SATURDAY, NOVEMBER 28th.
(Marconi-E.M.I.)

3.5, The Handyman: repairing a broken window. **3.20,** Movietone Magic Carpets: "Happy Days in the Tyrol." **3.30,** Fifteen-foot model of Coronation Procession. **3.45,** Cabaret: the Avlon Four (skaters).

9.5, Tap Dancers. **9.20,** Movietone Magic Carpets: "Diamonds in the Rough." **9.30,** The Handyman. **9.45,** Coronation Procession.

MONDAY, NOVEMBER 30th.
(Baird.)

3.5, James McPhee (tenor) and pipers of The London Scottish. **3.20,** Movietone Magic Carpets: "All is Safely Gathered In." **3.35,** Scenes from the Royalty Theatre production of "Marigold."

9.5, Repetition of 3.5 programme. **9.20,** British Movietone News. **9.30,** Scenes from "Marigold."

TUESDAY, DECEMBER 1st.
(Baird.)

3.5, Hand-sewn Shoes—demonstration of shoe-making. **3.25,** British Movietone News. **3.40,** Stories of the Canadian West told by "Snow-shoe." **3.45,** Bowyer and Ravol: ballroom and acrobatic dancers.

9.5, Repetition of 3.5 programme. **9.25,** Film: "All is Safely Gathered In." **9.40,** Repetition of 3.40 programme. **9.45,** Anne Ziegler and Gilbert Webster (xylophone).

WEDNESDAY, DECEMBER 2nd.
(Baird.)

3.5, The Two Leslies. **3.20,** Film: "All is Safely Gathered In." **3.35,** Ninth Picture Page: the Switchboard Girl.

9.5, Physical Training Display: Instructors of the Army School of Physical Training. **9.25,** British Movietone News. **9.40,** Stories of the Canadian West. **9.45,** Albert Sandler.

THURSDAY, DECEMBER 3rd.
(Baird.)

3.5, The Crown Jewels: Display of Duplicates of Collection in the Tower of London. **3.20,** British Movietone News. **3.30,** Ballet.

9.5, The Crown Jewels. **9.20,** Film: "All is Safely Gathered In." **9.30,** Ballet.

Multi-valve Receivers

LARGE receivers of the American type will never have much sale while the prices of valves remain as at present.

The cost of replacement of the eighteen valves in a certain U.S.A. receiver is £6 2s. 6d., as given by the London branch. The cost of eighteen English valves is somewhere in the neighbourhood of £16.

Chichester, Sussex.
W. W. WOODMAN.

Hong Kong S.W. Transmitter

IT may be of interest to your many readers in various parts of the world to know that a new modern short-wave broadcast transmitter has been installed and is now operating in Hong Kong.

The new transmitter is of 2.0 to 2.6 kW aerial power and replaces a small experimental transmitter of only 0.5 kW aerial power, but which was, nevertheless, heard well even in countries most distant from Hong Kong.

The new transmitter is designed to transmit on any one of four defined frequencies. The selection of these will be governed by seasonal conditions, and the particular frequency in use will be indicated by the call-sign as follows:—

ZBW2	6,090 kc/s	49.26 m.
ZBW3	9,525 ,,	31.49 m.
ZBW4	15,190 ,,	19.75 m.
ZBW5	17,755 ,,	16.90 m.

The hours of transmission are (H.K. time):—

Mon., 12.30-2.15 p.m., 5-11 p.m.
Tues., 12.30-2.15 p.m., 4-11 p.m.
Wed., 12.30-2.15 p.m., 4-11 p.m.
Thurs., 12.30-2.15 p.m., 5-11 p.m.
Fri., 12.30-2.15 p.m., 4-11 p.m.
Sat., 12.30-2.15 p.m., 4-12 p.m.
Sun., 10.00 a.m.-2.30 p.m., 4-10.30 p.m.

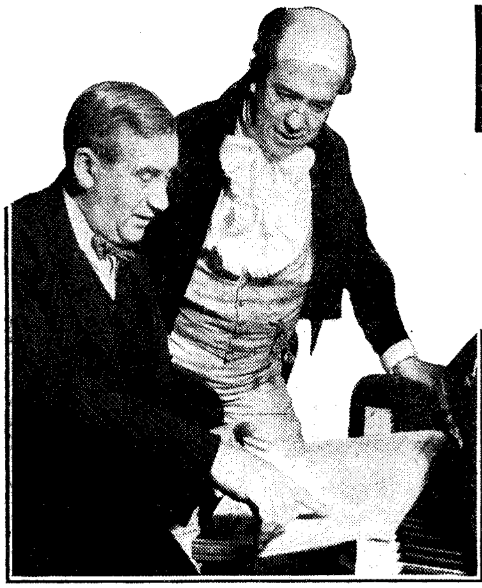
Both European and Chinese programmes are broadcast.

Hong Kong time is eight hours ahead of G.M.T., and our evening transmissions are, therefore, at an awkward time for European reception, but if any of your readers there or elsewhere pick us up, their reports, either direct or through the medium of your pages, would be appreciated.

Hong Kong. W. J. CARRIE,
Postmaster-General.

Listeners' Guide for

Outstanding Broadcasts at Home and Abroad



DICKENSIAN. Albert Coates, the composer of the opera "Pickwick," running through the score with William Parsons who takes the name role. This new opera comes into the National programme on Monday.

DEDICATED to "Lovers of Dickens all over the world," Albert Coates' new three-act opera, "Pickwick," which had its première under the patronage of His Royal Highness the Duke of Kent at the Royal Opera House, Covent Garden, on November 20th, provides a relay for National listeners on Monday at 8. This new work has been described as *The Pickwick Papers* set to music, for every word of the libretto is taken from that famous work of Dickens. It is a happy coincidence that it should be first produced in the centenary year of the publication of the *Papers*.

The first act, which is the only one being broadcast, opens with the Pickwickians at the Rochester manœuvres. Then follows the visit to Wardle's home, Dingley Dell, Jingle's elopement with Rachel and ends with Sam Weller's appearance at the George Inn.

The new British Music Drama Opera Company are producing this, and among the principals are William Parsons (Pickwick), Dennis Noble (Sam Weller), Samuel Worthington (Wardle) and Enid Cruickshank (Aunt Rachel). Albert Coates will conduct the London Symphony Orchestra.

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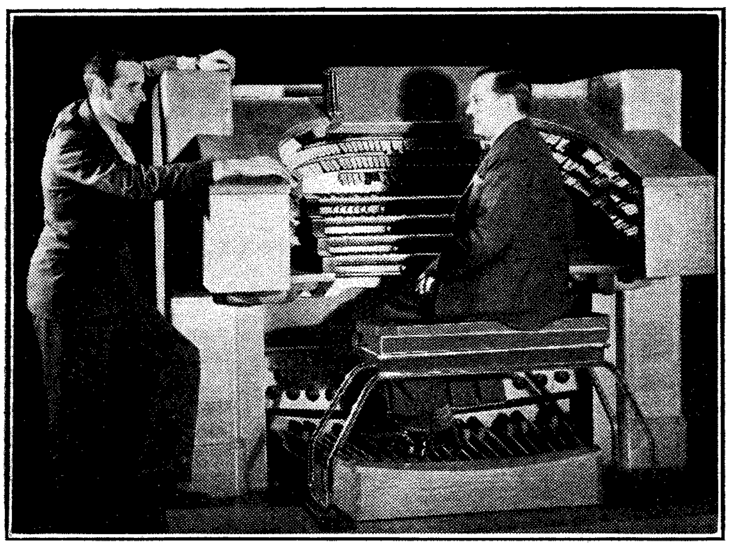
WHITEHALL ONE-TWO-ONE-TWO

LAURENCE GILLIAM, who is in charge of feature programmes, will produce another in the series depicting public services. He has already given us, among others, "Underground," "Gale Warning" and "Cable Ship," and now, as no doubt you have guessed from the heading, he is to deal with life in the police force with special reference to Scotland Yard. The programme, which will be broadcast at 9.40 on Sunday (Nat.) and 8 on Tuesday (Reg.), is divided into four sections, namely, the history of the Metropolitan Police; sound picture of methods by which a recruit for the Metropolitan Police is trained; examples of the varied nature of modern police work, including recordings and descriptions of the work of the mounted and river police, the C.I.D., and the Flying Squad, and the final section will depict the London policeman off duty.



REGINALD FOORT at the console of the Theatre Organ in conversation with Eric Maschwitz, Director of Variety. The organ's effects will be demonstrated by Reginald Foort in the variety programme at 8.15 (Reg.) on Wednesday.

PIANOFORTÉ

IT is a good test for quality in a receiver for it to faithfully reproduce pianoforte music and ample opportunity for such tests are afforded this week.

In the Special Recital Series for the current week Busoni's Pianoforte Music will be played by Egon Petri. These recitals are to be given on Sunday at 4 (Reg.), and Nationally on Tuesday at 6.25, Wednesday at 10.45, Thursday at 6.40 and Friday, December 4th.

During the recital by Pierre Bernac (tenor) and Francis Poulnec (piano) on Tuesday at 9.55 (Nat.), the latter will give a first performance of his new work, "Les Soirées de Nazelles."

The seventh Sunday Studio Orchestral Concert will be conducted by Julian Clifford and Solomon will play the Mozart Pianoforte Concerto No. 17.

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CONCERTS

ELGAR'S "The Dream of Gerontius," which has not been broadcast in London since 1931, will fill the programme of the fifth B.B.C. Symphony Concert at the Queen's Hall on Wednesday. The work will be conducted by Adrian Boult and sung by the B.B.C. Choral Society, the soloists being Muriel Brunskill, Heddle Nash and Horace Stevens. Part I will be broadcast at 8.15 and Part II at 9.20 (Nat.).

From the Free Trade Hall, Manchester, will be heard the Hallé Concert conducted by Sir Thomas Beecham on Thursday at 7.30 and 8.40 (Reg.). The programme includes Elgar's Overture "Cockaigne" and the suite "Façade" by William Walton.

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FROM SEASIDE CONCERT PARTIES

THE theatre organ will, for the first time, be used to accompany a variety show on Wednesday, when Harry S. Pepper and John Watt produce a programme at 8.15 (Reg.) featuring concert party artistes discovered by Harry Pepper and Davy Burnaby during their tours for the series "From the Seaside."

John Watt will introduce each artiste, telling how and where he or she was discovered.

For the inaugural broadcast of the theatre organ, John Watt and Reginald Foort were to have combined in demonstrating the multitudinous effects of the organ, but this had to be cut out of the programme. It will be introduced into this show with John Watt telling a heartrending story, while Reginald Foort does his best to produce the effects at the organ.

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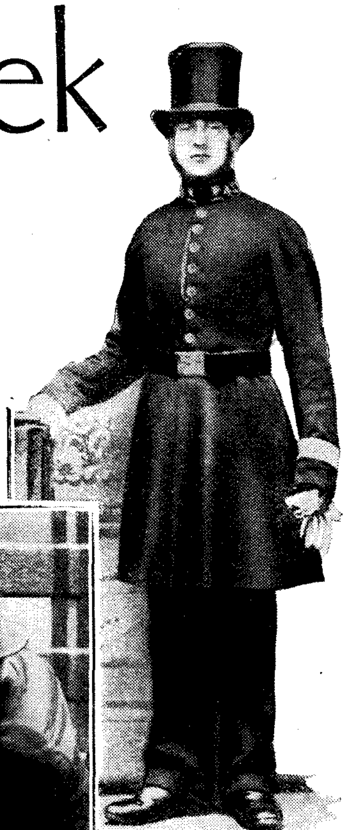
ST. ANDREW'S DAY

THE spirit of St. Andrew's Day is to be maintained in the programmes on Monday when Edwin Muir, the distinguished Scottish writer, gives expression to his thoughts in a personal way on what Scotland means to him. He has compiled from literature, linking the passages with his own poetry, a document that should impress listeners in a way which has probably never been done before on St. Andrew's Day.

On Sunday a Scottish service from St. Columba's, Pont Street, will be broadcast at 3, when the Rev. Archibald Fleming will preach and the lesson will be read by the Rt. Hon. W. S. Morrison.

Details of the week's Television programmes will be found on p. 579.

the Week



GUARDS' BANDS

LOVERS of military band music will want to tune to the National wavelength on Saturday at 8.15 to hear the massed bands of His Majesty's Coldstream, Scots, Irish and Welsh Guards from the concert at the Alexandra Palace. The last item in the programme is Tchaikovsky's 1812 Overture.

PEELERS. Many changes in the Police Force have taken place since policemen wore a uniform with toppers like this. On the left 20th century policemen are making an arrest during disturbances at the Ministry of Labour. The programme featuring the Police Force should be well worth tuning in.

OPERA FROM ABROAD

OPERA lovers have a wide choice of productions from the Continent. To-night, from the State Opera, Prague relays a Czech opera evening at 6.30 with one-act opéras-comiques, "The Pig-headed Peasants" (Dvorák) and "In the Well" (Blodek).

From Paris PTT and other French Regional stations will be heard on Friday at 8.30 Schiller's great trilogy "I Picolomini," "Wallenstein's Camp" and "Wallenstein's Death," performed by the Comédie Française Players. In its entirety this work would take about eight hours, but it has been compressed into about two-and-a-half hours for broadcasting.

Saturday's principal opera broadcast consists of Verdi's "Aïda" from Rome at 7.45. From Radio Paris at 8.45 on the same evening comes "Antar" by Gabriel Dupont, a French composer who died in 1914. This sumptuous work, full of life and colour, was his swan song.

A matinée performance of Puccini's immortal "La Bohème" will be given by Paris PTT from 1.30 to 4.45 on Sunday. The same day brings Humperdinck's fairy opera, "Hansel and Gretel," from Berlin (Funkstunde) at 7 and Wagner's "Valkyrie," relayed from the Dresden Opera by Leipzig, at 5. Busoni's "Turandot" comes from Milan at 7.45 on Sunday, and from Rome at the same time on Tuesday. Thursday brings Puccini's tragic opera "La Tosca" from Milan at 8.

BERLIN RESTAURANTS

THE bands of five different Berlin restaurants are to be included in a special series of relays to be broadcast from Berlin from 7.10 to 9 on Thursday. This will afford a good opportunity to hear a representative programme by German dance bands.

HIGHLIGHTS OF THE WEEK

FRIDAY, NOVEMBER 27th.

Nat., 6.25, Violin Recital: Max Rostal. 7.20, Scottish Dance Music: The Strings of the B.B.C. Scottish Orchestra. 8, The Kentucky Minstrels.

Reg., 6, The B.B.C. Dance Orchestra. 8, G. D. Cunningham at the B.B.C. Concert Organ. 8.45, "The Vagabond King."

Abroad.

Leipzig, 7.5, Winter Relief Fund Concert, by the Dresden Philharmonic.

SATURDAY, NOVEMBER 28th.

Nat., 6.45, Mantovani and his Dance Orchestra. 7.30, "In Town To-night." 8.15, Massed Bands from the Alexandra Palace. 9.20, Music Hall.

Reg., 2.30, "La Bohème" from Sadler's Wells. 4.15, Kentucky Minstrels. 6, The Walford Hyden Magyar Orchestra. 8.20, The British Women's Symphony Orchestra.

Abroad.

Brussels I, 8, Concert by the "Musique des Guides" from the Conservatoire.

SUNDAY, NOVEMBER 29th.

Nat., 4.20, Eugene Pini and his Tango Orchestra. 5.20, Comic Opera in Beethoven's Time presented by the Opera Group. 8, The Archbishop of Canterbury at Concert Hall Service. 9.40, Scotland Yard Feature Programme.

Reg., 5, B.B.C. Military Band and Mischel Cherniavsky ('cello). 6.20, Concert from Prague. 9.5, Sunday Orchestral Concert, 7.

Abroad.

Leipzig, 5, "The Valkyrie" from the State Opera, Dresden.

MONDAY, NOVEMBER 30th.

Nat., 6.40, B.B.C. Singers (A) and Albert Boorsanger (violin). 7.20, Entertainment Parade, 5. ¶Savoy Orpheans. 9.35, St. Andrew's Day Programme.

Reg., 6, Reginald King and his Orchestra. 8, "Pickwick" from Covent Garden. ¶B.B.C. Theatre Orchestra and the Gresham Singers.

Abroad.

Kalundborg, 8, Mozart, Schubert, Rimsky-Korsakov Concert.

TUESDAY, DECEMBER 1st.

Nat., 8, Van Phillips and his Two Orchestras. 8.30, Guitar Recital: Emilio Pujol and Matilde Cuevas.

Reg., 6, B.B.C. Military Band and Samuel Worthington. 7.30, Esta Stein's Yiddish Chauve Souris Company and Jewish Male Choir. 8, Scotland Yard Feature Programme.

Abroad.

Paris PTT, 8.30, Ravel Concert from the Salle Gaveau.

WEDNESDAY, DECEMBER 2nd.

Nat., 7, Violin Recital: Alfredo Campoli. ¶Jack Hylton and his Band. 8.15 and 9.20, Symphony Concert from the Queen's Hall.

Reg. 3.15, International Football Match: England *v.* Hungary. 7.20, Students' Songs. 8.15, Variety.

Abroad.

Brussels I, 8, Prokofiev Concert.

THURSDAY, DECEMBER 3rd.

Nat., 5.15, Harry Roy and his Band. 6.20, This Way Out: John Hilton. ¶"Away to the Hills": Musical Play.

Reg., 6, B.B.C. Dance Orchestra. 6.40, From the London Theatre. 7.30 and 8.40, Hallé Concert from Manchester. ¶The Alfredo Campoli Trio.

Abroad.

Bucharest, 7.15, Bucharest Philharmonic from the Atheneum (relayed by Brasov).

SAXOPHONE

THE famous Danish exponent of classical music on the saxophone, Sigurd M. Rascher, who was heard from the Proms. in September, will play from 8 to 8.25 in the Kalundborg programme on Sunday.

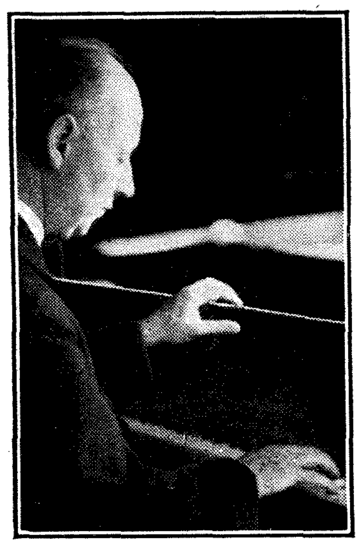
NORTHERN MUSIC

WORKS of famous Finnish, Swedish and Norwegian composers will be combined in a special concert from Hamburg on Wednesday at 7.45.

THURSDAY CONCERT

THE seventh Thursday Concert from the State Broadcasting Building to be broadcast by Kalundborg at 7.10 includes works by Paganini and excerpts from Lalo's Symphonie Espagnole played by Nathan Milstein (violin). The augmented Wireless Symphony Orchestra will be conducted by Fritz Busch.

THE AUDITOR.



EGON PETRI, the eminent German pianist, who was heard in the Symphony Concert last Wednesday, will play Busoni's pianoforte music this week. He was one of the famous composer's pupils.

In Other Fields

Valves and Gas-filled Relays in Science and Industry

AFTER dealing with such special-purpose valves as voltmeter and electrometer triodes, the author now goes on to describe gas-filled valves of various types and their applications for non-radio purposes.

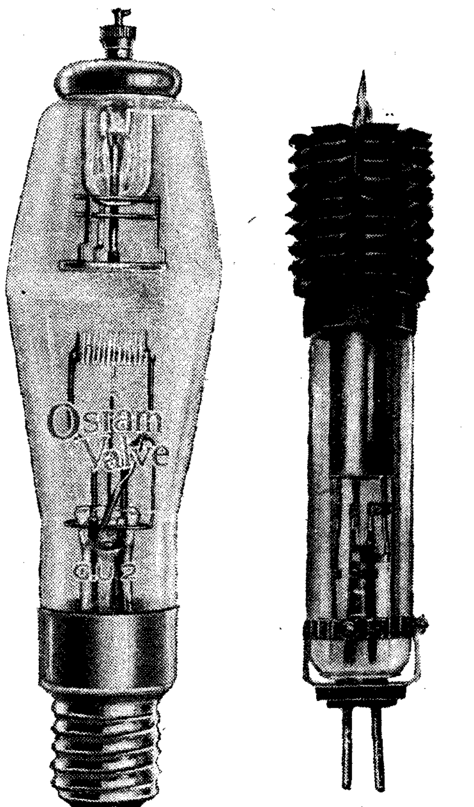
(Concluded from page 527, November 20th issue)

By F. E. HENDERSON, A.M.I.E.E.

(Osram Valve Dept., The General Electric Co., Ltd.)

THE development of gas- or vapour-filled valves of the hot-cathode type for industrial purposes is restricted to diodes for rectification of AC supply, although of recent years the gas-filled relay, which includes a control electrode, or grid, has made its appearance for various applications.

The soft diode may be roughly divided into two groups: first, that which contains an inert gas such as argon, the valves in this group being intended for rectification of currents from 1 to 100 amperes at comparatively low voltage; and, secondly, a group normally containing mercury vapour and intended for the rectification of higher voltages.



(a) (b)

Fig. 8.—(a) A high voltage mercury-vapour rectifier, Type GU2, giving an output up to 2 amps. and (b) a GU8 rectifier, similar to Type GU2, but giving a larger output.

The principal application of the low-voltage high-current type is to battery-charging apparatus, where it is fairly extensively employed. Mercury vapour-filled rectifiers in the form of a thermionic valve, as distinct from the mercury arc rectifying equipments (which are properly included as a branch of heavy electrical engineering), are now available for dealing with a very wide range of working voltages.

Illustration, Fig. 8 (*a*), shows the GU2 type, which is capable of giving an output of 2 amps. at 3,000 volts in a bi-phase half-wave circuit; and Fig. 8 (*b*) illustrates a similar valve of type GU8. Six valves type GU8 in a three-phase full-wave circuit will deliver an output of 20,000 volts 12 amps. DC.

With all gas-filled, or mercury vapour-filled, valves the current flowing through the valve, while still limited as to its maximum permissible value by the saturation emission of the cathode, is not limited by space charge, and thus anode voltages of 10 to 20 volts produce the full saturation current of the cathode. A small anode potential (10-15 V.) will give the electrons emitted from the cathode sufficient energy to provide ions by collision with the atoms of the gas. The conduction of current is thus accompanied by a discharge which appears as a glow in the tube. Owing to the low impedance of the gas-filled valve under conditions of ionisation, the actual current passing through it will depend only upon circuit conditions, and it is therefore important that the external circuit should always contain sufficient resistance to limit the current to the manufacturer's rating of the valve.

A further extremely important characteristic of the mercury vapour valve is the necessity for the cathode to be heated to its normal emitting temperature before any anode current is allowed to pass. This, however, is not likely to prove such a big disadvantage in large types used for industrial purposes than perhaps is the case with the smaller types subjected to more frequent switching on and off.

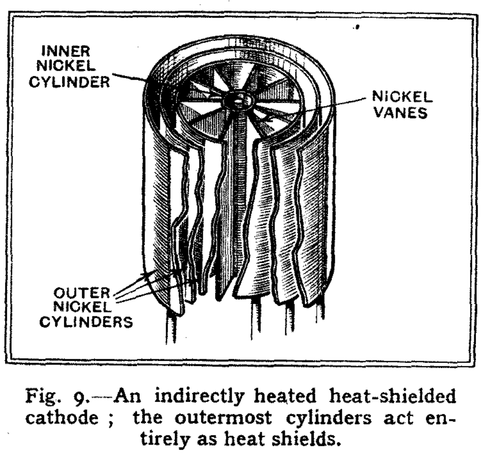


Fig. 9.—An indirectly heated heat-shielded cathode; the outermost cylinders act entirely as heat shields.

In mercury vapour-filled valves, particularly where used in high-voltage circuits, it is usually important to maintain the ambient temperature between certain limits, and with large valves it is common practice for the temperature of the surrounding air to be thermostatically controlled. Not only must the ambient air temperature be kept below the maximum value permitted, but these valves are very human in their reaction to draughts, which are likely to prove fatal by causing condensation of the mercury above the anode, or by lowering the temperature to a dangerous level.

In addition to the advantage of increased current-carrying capacity by the use of a low pressure of gas instead of a vacuum, there is the possibility of using various devices to increase the efficiency of the cathode which are not feasible in the high-vacuum rectifier. Such, for instance, is an improved cathode known as a "heat-shielded" cathode, which allows the introduction of indirect heating and almost totally encloses the electron-emitting surfaces, with less risk of contamination of other parts of the valve with particles of loosened emissive coating.

An illustration of an indirectly heated heat-shielded cathode is given in Fig. 9. The cathode consists of a number of vanes of thin nickel mounted radially on a nickel cylinder, these being surrounded by an outer nickel cylinder. The spaces enclosed between the vanes are coated with the emitting material, and the whole is heated internally by a tungsten heater mounted inside the inner cylinder. Heat-shielded cathodes of this type can be made to give very high emission efficiencies, even up to about 3 amps. peak emission per watt, which compares with 0.1 amp. peak per watt for a simple straight oxide-coated filament.

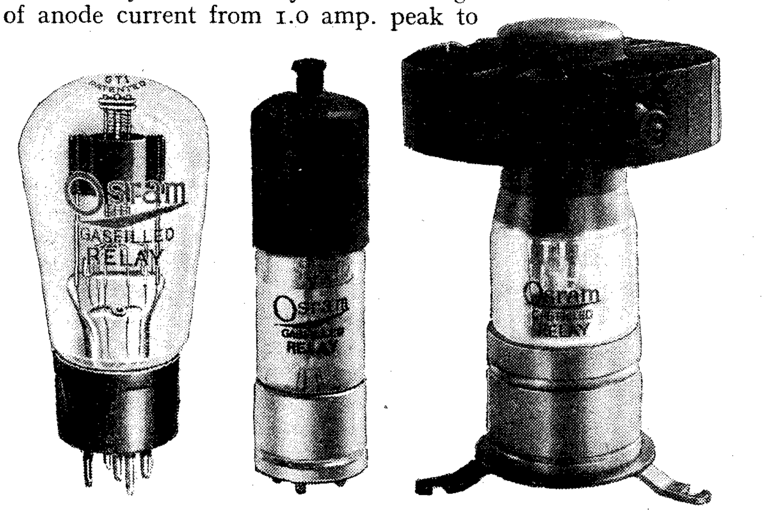
The importance of observing the

In Other Fields—

cathode pre-heating time is increased with such a cathode, and, with a cathode rated at 100 watts, this may be of the order of fifteen minutes.

The development of gas-filled relays has received a good deal of attention both in America and in this country, and the applications of this device in industry are possibly only just being appreciated by electrical engineers. The principle of the gas-filled relay has already been described in these pages[1] and consists of the introduction of a control electrode (which might be called the grid) into an inert gas- or mercury-vapour-filled rectifier, the introduction of this electrode serving to prevent the discharge, so long as the voltage applied to the grid is kept more negative than a certain value dependent on the anode voltage.

Typical gas-filled relays developed in this country commercially cover a range of anode current from 1.0 amp. peak to 25 amps. peak, or from 0.3 amp. average value to 8.0 amps.



(a) (b) (c)

Fig. 10.—Typical gas-filled relays: (a) Type GT1; (b) Type GT5E; (c) GT25E.

Illustrations of gas-filled relays included in this range are given in Fig. 10 (*a*) GT1, Fig. 10 (*b*) GT5E, Fig. 10 (*c*) GT25E.

The GT1 is designed with an indirectly heated cathode containing a heater of 5.2 watts, and will withstand an anode voltage of 1,000 peak with an RMS value of anode current up to 0.5 amp. The GT5E has an indirectly heated cathode with an air-cooled anode, and is fitted with a heater rated at 20 watts. This tube is capable of withstanding an anode voltage of 1,000 watts peak, with a maximum current of 2.5 amps. RMS.

A 12-amp. Output

The GT25E is a larger tube, also employing the air-cooled anode but designed with a heat-shielded cathode as previously described. The heater in this relay is rated at 40 watts, and a maximum anode current of the order of 12.5 amps. RMS for an anode voltage of 1,500 peak.

The simplest application of the gas-filled relay is as a trigger device, where a small variation of grid voltage is used to cause the starting of a steady anode current. So used, the relay will provide a permanent indication of a single transient effect of any kind which can be converted into a voltage variation, however short in duration. The anode current may be made to perform various functions, such as working an alarm, starting up a motor or operating a relay, or, for instance, it may be used in conjunction with a contactor to open a circuit in the event of an overload occurring in that circuit.

With DC applied to the anode it is necessary to reset the relay each time it is operated by removing the anode voltage momentarily and thus allowing the grid to regain control.

A common application of the relay as a simple trigger device is in conjunction with the photo-electric cell, together with an electro-magnetic relay, so that the gas-filled relay is made to break its own anode circuit after each discharge. This method is applicable to counting mechanisms, and, as such, is employed to some extent by industrial concerns.

As it is capable of carrying large currents without excessive internal dissipation, the relay is able to perform the function of a contactor, switching on heavy currents under the control of a small grid voltage change. The power necessary to control a current of several amperes may be only a few milliwatts.

In an inverter to change DC to AC voltage, two gas-filled relays are normally employed; the method has been adequately described elsewhere. The inverter can be made self-excited, and then provides a convenient source of AC supply (not necessarily of sinusoidal wave form) of any voltage or wattage, dependent upon the size of relays employed, from a DC source without the introduction of any mechanical moving parts. The employment of gas-filled relays in inverter circuits should enable efficiencies of 90 per cent. or over to be realised with high-voltage DC supplies. Special precautions in the design of the inverter circuit are necessary in order to deal with loads of poor power factor and to make the circuit proof against accidental short-circuits.

By the application of an AC voltage to the anode the relay is automatically self-resetting during each cycle of the anode supply voltage, and in this case, by means of a variable applied grid bias, the average anode current can be controlled continuously from zero to that corresponding to current flowing during the whole half-cycle in which the anode voltage wave is positive. With an AC voltage applied also to the grid, the flow of anode current can be controlled by the phase relationship between the anode and grid voltages, the average rectified current passing through the tube changing from zero to its maximum value.

Typical applications of this may be found in furnace temperature control, DC motor speed control, or voltage control of a generator by variation of field excitation.

A further application which may have a promising future is that of dimming lighting circuits, in which the amount of light given by an installation may be varied from zero to full brilliance remotely controlled by means of a small potentiometer. Very beautiful effects may be obtained in this way by combining and changing the value of illumination given by a number of lamps of different colours, such as in stage lighting, etc.

The capabilities of the gas-filled relay have already been successfully demonstrated, and there is little doubt that it will ultimately take its place with other devices as a standard piece of electrical equipment.

Mention has not been made here of the application of standard amplifying triodes, etc., to industrial use, though these are becoming increasingly employed, particularly for public address work, and as electrical "call-boys" in hotels, etc.

The scope of thermionic valves applied in one form or other to traffic control is unlimited, and such experiments as have already been conducted on these lines indicate the possibilities in this direction.

[1] *The Wireless World*, January 13th, 1932.

The Radio Industry

HIS MAJESTY THE KING has granted his Patronage to the Electrical Industries Benevolent Association.

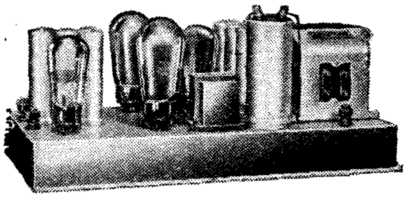
We have received from the London office of the Leipzig Fair (First Avenue House, 45, High Holborn, London, W.C.1) a leaflet describing the general scope of the Fair and also a technical report (No. 13) containing a general survey of German manufacturing activities in the fields of broadcasting and television. Free copies of these publications are available to any reader who may be interested.

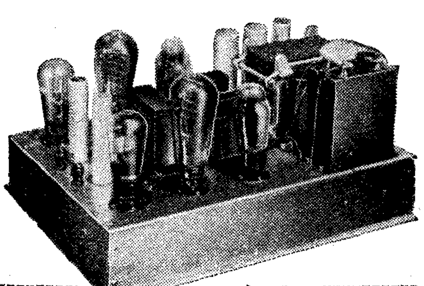
In preparation for the Coronation festivities, the bells of Manchester Town Hall are being re-cast. But this fact did not prevent the new Lord Mayor of Manchester from being rung into office in the traditional manner; loud speakers fitted behind the louvres of the bell tower were used to reproduce gramophone records of appropriate peals specially prepared for the occasion. This novel "relay" was carried out by Holiday and Hemmerdinger.

The General Electric Company has just produced a high-impedance moving-coil loud speaker for use with G.E.C. and other sets fitted with high-impedance extension speaker sockets. Three impedances (3,000, 6,000 and 9,000 ohms) are provided, and the unit, which has a nickel-aluminium permanent magnet, is housed in a walnut cabinet. The price is 52s. 6d.

British Television Supplies, Ltd., Faraday House, 8-10, Charing Cross Road, London, W.C.2, have issued a booklet describing ten circuits (short-wave and all-wave sets, etc.) in which B.T.S. coils are employed.

Resistance-Coupled Amplifiers





Part IV.—VALVE CAPACITIES

THE earlier articles of this series have dealt with the isolated stage of amplification. In this article it is shown that the following stage can modify the performance because of feed-back through the grid-anode valve capacity.

IT has already been shown that the response of an amplifier at high frequencies is limited by the circuit capacity, and for a given degree of amplification, the lower the capacity the higher the frequency to which uniform amplification can be maintained. This capacity is represented in Fig. 11 by the condenser C1, but it usually has no physical existence as such, for it is made up of the sum of the various unavoidable capacities existing between different parts of the circuit.

The first component of C1 is the anode to cathode capacity existing in the valve V1; the value of this depends on the construction of the valve, but with ordinary small triodes it is some 2-8 μμF. The second component consists of the stray wiring capacities and the valveholder capacities of V1 and V2; the value of this depends on the method of construction and upon the components employed, but it need not generally exceed 10 μμF. The third component is the grid to cathode capacity of V2 under static conditions, perhaps 3-8 μμF. The fourth component is a fictitious capacity which represents the effect of feed-back through the grid to anode capacity of V2,—it may be negligible or very important.

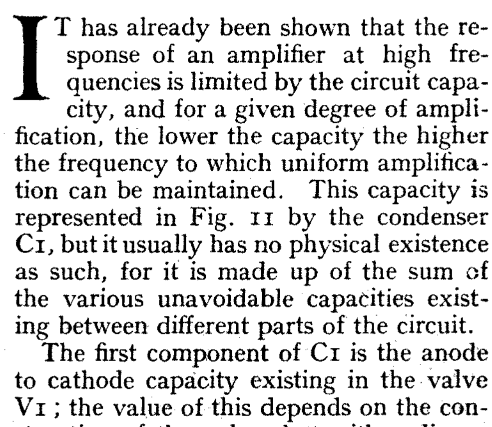


Fig. 11.—The effects of feed-back through the valve capacity can be represented by an alteration in the value of the condenser C1.

This fictitious capacity we shall for brevity denote by the symbol Ci, just as we shall denote the grid-anode capacity by Cga. The value of Ci depends upon the value of Cga, the characteristics of the valve and upon the nature and magnitude of the anode circuit load impedance which are represented in Fig. 11 by a resistance RL and a reactance XL in parallel.

The Input Capacity

When the load impedance of V2 is a resistance coupling the components making up the load will be similar to those used for the coupling between V1 and V2, consequently we can use the same reference letters for them, but distinguish them by the addition of a double primer ("). Thus RL = R" = R1"R2"/(R1" + R2") and XL = 1/ωC1". The input capacity of V2 is then given accurately by

$$C_i = C''_{ga}\left\{\frac{1 + g''r'' + \omega^2 C''^2_1 r''^2 (1 + C''_{ga}/C''_1)}{1 + \omega^2 C''^2_1 r''^2 (1 + C''_{ga}/C''_1)^2}\right\} \quad \ldots\ldots\ldots (5)$$

Under two particular conditions this equation can be simplified. The first is when $\omega C''_1 r''$ is much smaller than unity; then

$$C_i = C''_{ga}(1 + g''r'') \quad \ldots\ldots\ldots (6)$$

and the second is when C_1'' is much larger than Cga; then

$$C_i = C''_{ga}\left(1 + \frac{g''r''}{1 + \omega^2 C''^2_1 r''^2}\right) \quad \ldots (7)$$

As an example, suppose that V2 is an MHL4 valve having μ = 20, Ra = 10,000Ω, so that g" = 2 mA/V., and it is used with R2" = 0.25 MΩ and R1" = 25,000Ω while C1" = 50 μμF. Let C"ga = 7 μμF., including stray capacities.

We see that $C''_{ga}/C_1 = 7/50 = 0.14$ while r" = 6920Ω (1/r" = 1/Ra + 1/R1" + 1/R2"). At 10,000 c/s, therefore, $\omega C1''r'' = 6.28 \times 10^4 \times 5 \times 10^{-11} \times 6.92 \times 10^3 = 0.0217$; this is sufficiently smaller than unity to permit equation (6) to be used for all frequencies lower than 10,000 c/s. We thus find that $Ci = 7 \times 10^{-12} (1 + 2 \times 10^{-3} \times 6.92 \times 10^3)$

$$= 1.038 \times 10^{-10}\ F. = 103.8\ \mu\mu F.$$

This is quite an appreciable capacity and its importance can be understood. In estimating, for estimation is all that is usually possible, the capacity C1 of the first stage, we thus tabulate the various components as follows:—

Anode-cathode capacity of V1	= say 2 μμF.
Stray wiring capacities	= say 10 μμF.
Grid-cathode capacity of V2	= say 4.5 μμF.
Input capacity of V2 due to feed-back..	= say 104 μμF.
Total	= C1 = 120.5 μμF.

The circuit values can then be determined in accordance with the rules given in Part III. It should be noted that there is no harm in overestimating the value of C1, for it will only mean that the actual response curve of the amplifier will be better than the calculated. If it is underestimated, then the high-frequency response will be poorer than that required.

The calculation of the response curve and the input capacity is quite straightforward except in the case of the output stage. One requires to know the input capacity of this valve in order to design the coupling preceding it. It cannot be calculated from the equations already given, however, for its anode circuit load being the impedance of a loud speaker it cannot be represented by a resistance and a capacity in parallel. It is not difficult to calculate it if the impedance of the loud speaker is known, or rather its effective resistance and reactance, but it rarely is. The best approximation for ordinary purposes, therefore, is probably to assume that the valve works into a resistance load, and to use equation (6) taking r" as equal to the resistance of the output valve in parallel with its load resistance.

Kellys Engineering Trades Directory, 1936.

THE twenty-second edition of this famous directory of the engineering and allied trades has made its appearance. It contains, among other things, a classified list of the many trades associated with the engineering industry, the names of the various firms being arranged alphabetically under their respective trades.

In addition, there is another section in which can be found the names and addresses of firms listed under their respective towns and villages, these latter being classified under their counties. The directory may be obtained from Kellys Directories, Ltd., 186, Strand, London, W.C.2, price 50s.

Broadcast Brevities

NEWS FROM PORTLAND PLACE

Letters in Demand

THE idea has gained ground in some quarters that the B.B.C. no longer requires letters of praise or criticism, having acquired enough experience in fourteen years of broadcasting to know the public's likes and dislikes without any prompting.

Actually, Portland Place was never more eager to receive listeners' letters than to-day.

What One Letter May Do

The contents of the daily post-bag are scrutinised with the greatest eagerness. Many a correspondent, living perhaps in an obscure village or small town, would be surprised if he discovered what a commotion his humble communication sets up amongst the mandarins at Broadcasting House. Committees have been known to sit in conclave over a single letter and to re-shape programme plans accordingly.

Moral: Don't hesitate to give the B.B.C. your point of view. At least you will get a courteous acknowledgment; quite possibly you may set whole departments buzzing along new lines of activity.

Unknown Benefactor

HELPFUL criticism is always valued at Broadcasting House. Last week an envelope addressed to a well-known vocal ensemble contained nothing but a throat lozenge.

On Christmas Day

C. DENIS FREEMAN and M. H. Allen have again collaborated to produce a special feature on December 25th—"The Christmas Journey: A Masque of the Nativity," with music by Frederick Stevens. This will be heard at 8.30 by Regional listeners.

When the Cap Doesn't Fit

WHEN issuing warnings to unlicensed listeners, the B.B.C. is faced with a difficult situation, as is obvious from complaints received from certain sensitive listeners in the Belfast area.

Apparently the Northern Irish listener resents pointed microphone references to the fact that "no wireless receiving apparatus may be worked without a licence," the implication being that listeners in that district are not honest.

How to avoid offending tender susceptibilities is a problem. The B.B.C. recommends that honest listeners should turn a deaf ear to the warnings: it certainly cannot undertake to drop the exhortations, neither can it fall in with one listener's suggestion that a buzzer be sounded three times before a licence warning is issued.

A Television Christmas?

BRIGHT and original plans for a television party in Alexandra Palace studios on Christmas Day have been knocked on the head. Sober reflection has persuaded producers and everybody else concerned that you can't "produce" a spontaneous party like an ordinary television show; besides, there is a general feeling that ordered conviviality isn't easy in the glare of several dozens of kilowatts. In sound broadcasting, where you can't be seen, it is another matter!

But there will be television on Christmas Day. If there is no show late at night, owners of television sets will be feasted with a special production in the afternoon, perhaps running to two hours instead of one.

A.P.'s Signal Strength

THE task of measuring television signal strength around London is likely to keep the B.B.C. engineers somewhat impatiently employed for some time to come. "Impatiently," because the whole job is a singularly tantalising one.

Unlike common or garden broadcast waves, these ultra-short waves are revealing a London which simply bristles with traps and gins for the unwary.

Patchy Reception

Field strength cars patrolling the streets from Barnet to Balham and from Ealing to East Ham have revealed that conditions of reception vary tremendously even over a small area. Hills, or even slight declivities which are scarcely noticed in a town, account for a remarkable falling-off in signal strength in certain districts; in other places the influence of steel-framed buildings is severely felt.

Sound No Criterion

Reports of the reception of sound signals from Alexandra Palace have been received from many distant parts of the country, but it is difficult to interpret these in the terms of a reliable television service. In other words, the only satisfactory way in which the ordinary man can test the value of a television signal is to see it as a picture.

The Electron Camera

ALTHOUGH no preliminary announcement was made, no one who saw the first transmissions with the Electron camera from the Baird studios at Alexandra Palace last week could have doubted that something new was "on the air." An adaptation of the Farnsworth camera, the new instrument calls for studio technique closely resembling that required for the Emitron, a fact which was obvious to televiewers familiar with the Marconi-E.M.I. methods of production.

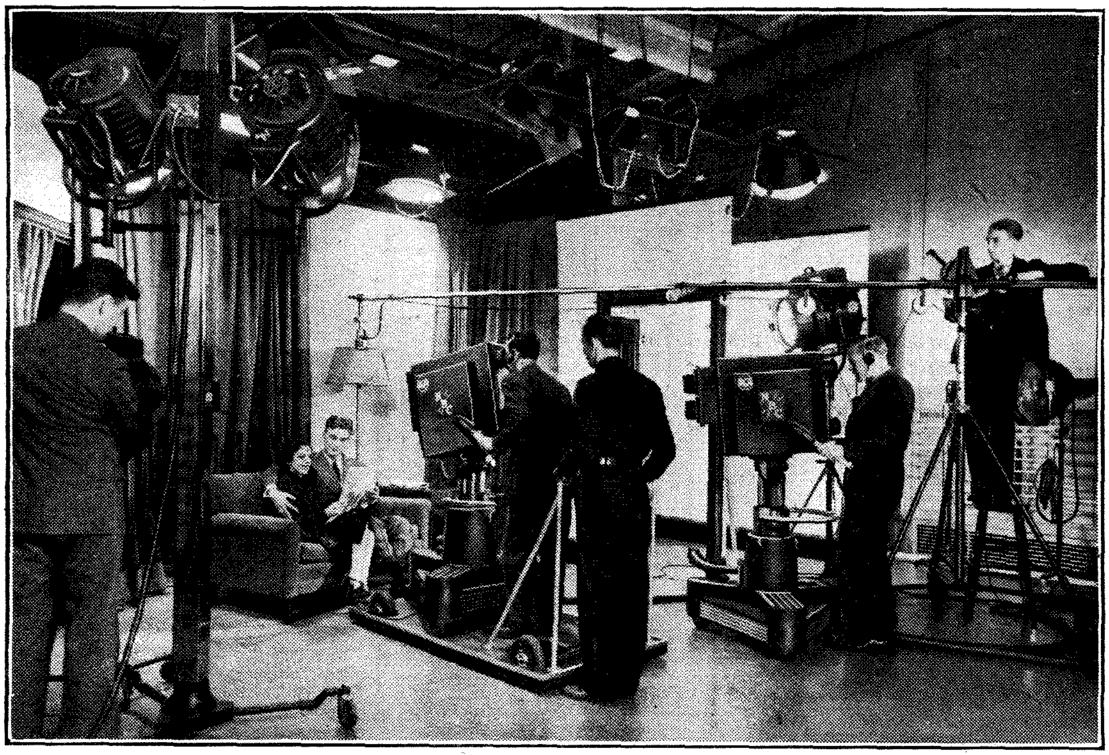
Television by Searchlight

QUITE the most ambitious effort in television "O.B.s." will be made on December 12, when two anti-aircraft guns are to be seen at night in Alexandra Park, illuminated by searchlights. Cecil Lewis has arranged this programme, in which the 61st (11th London) Anti-Aircraft Brigade will show how team work goes to the successful operation of a battery. Searchlights—there will be three—are being brought by the 36th Anti-Aircraft Battalion of the "R.E.s."

The whole production will call for some smart work with the Emitron camera, as an attempt will be made to stage a dummy attack by hostile aircraft.

Gun Drill

In the afternoon transmission on the same day the guns and searchlights will be seen, but this item will, of course, lack the glamour of the night scene. Televiewers will, however, see how gun drill is carried out, how the range predictor is worked, and how the "listening" squad gauge the speed and direction of approaching aircraft.



AMERICAN TELEVISION. This picture, taken in the N.B.C. television studio during an experimental transmission, shows an R.C.A. Iconoscope camera at work. The second camera, seen on the right, is fitted with twin lenses and comes into action for "close-ups" only.

Recent Inventions

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

Brief Descriptions of the more interesting radio devices and improvements issued as patents will be included in this section

PIEZO-ELECTRIC CRYSTALS

THE ordinary quartz crystal will oscillate at constant frequency at a given temperature, though this frequency will tend to "drift" above or below the standard value with any rise or fall in the surrounding temperature.

It is, however, possible to cut a slab of crystal from the mother quartz so that it has a "zero" temperature coefficient; that is to say it will oscillate at the same frequency at all temperatures within a given range.

According to the invention the required result is secured by cutting a thin slab so that its flat side lies at a certain angle to the electrical and optical axes of the mother crystal. The crystal is then energised so that it oscillates transversely, and not in the direction of its thickness.

Telefunken Co. Convention date (Germany) August 10th, 1934. No. 452236.

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SOUND AND PICTURE PROGRAMMES

A COMBINED sound and picture programme is radiated on two carrier-waves which are separated in frequency by approximately two per cent. Both carriers are received on the same aerial and are fed to a single local-oscillator, which also functions as an anode-bend detector. The two resulting intermediate-frequencies are fed to a first amplifier-stage, where they are separated out by filter circuits in the anode circuit, and are then passed on for independent amplification.

Radio-Akt. D. S. Loewe. Convention dates (Germany) February 9th and April 28th, 1934. No. 451670.

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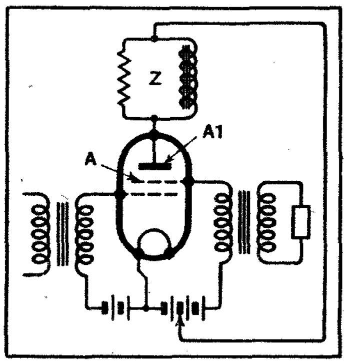
THERMIONIC AMPLIFIERS

DISTORTION due to valve curvature is avoided by inserting, beyond a perforated anode A, a further electrode A1 which is connected through an external circuit to an impedance Z which influences its potential. For a particular value of grid voltage, the anode current at first falls, as the potential on A1 increases, owing to the greater number of electrons which are drawn through the perforations of the anode. But as the potential of A1 rises still further, secondary emission takes place from it, and some of the secondary electrons return back to the anode A, and so increase the anode current. This interaction is utilised to secure a linear relation between grid voltage and anode current.



Valve and circuit for reducing distortion due to non-linear relation between grid volts and anode current.

Standard Telephones and Cables, Ltd., W. T. Gibson, D. H. Black, and W. Lawrence. Application date February 8th, 1935. No. 451661.

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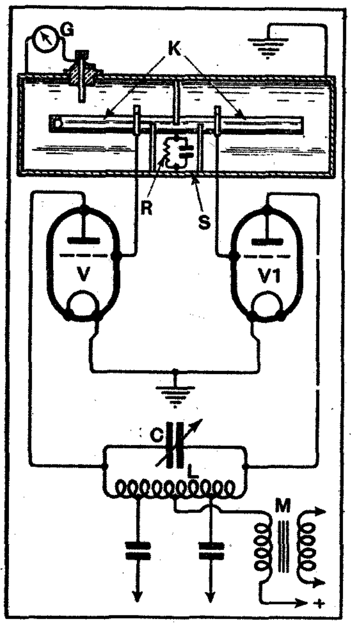
SHORT-WAVE OSCILLATORS

TWO valves, V, V1, arranged in push-pull, feed high-frequency oscillations to a tuned output circuit L, C, signal modulation being effected at M. The generated carrier-frequency is controlled or stabilised by a low-loss conductor K, which is connected symmetrically across the grids of the two valves. The conductor K is half the working wavelength or an odd multiple of that length. The cathodes are earthed directly, and the mid-point of the conductor K is earthed indirectly through a shunted resistance R and the shield S, the system oscillating through the inter-electrode capacities. A thermo-galvanometer G indicates when the system is operating properly.

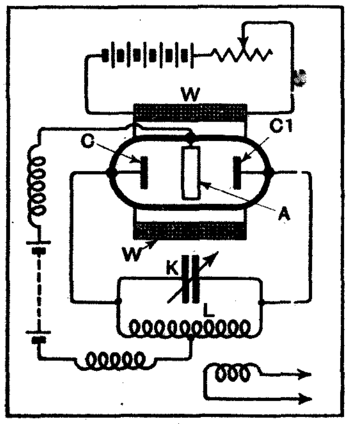


Simplified form of resonant line for control of short- and ultra-short-wave oscillator.

Marconi's Wireless Telegraph Co., Ltd. (assignees of N. E. Lindenblad). Convention date (U.S.A.) February 16th, 1935. No. 451568.

COLD-CATHODE OSCILLATORS

THE so-called "electron multiplier" is a cold-cathode tube in which electrons emitted, say, by the action of light, from one electrode are caused to impact against a second electrode with such velocity that secondary electrons are produced to swell the original stock. By repeating this process a number of times, very high amplification is obtained. The present invention is concerned with a method of producing sustained RF oscillations in such a tube.



Method of generating RF oscillations in a cold-cathode valve.

As shown in the Figure the electron-multiplier consists of two cold cathodes C, C1 and a central ring-anode A, the tube being surrounded by a winding W to produce an intense magnetic field, which focuses the electrons into a stream so that they pass to and fro through the ring-anode A. Each cathode is coated with an emissive layer of caesium-silver hydride. The main oscillatory circuit L, K is branched across the two cathodes, the coil L being connected at its mid-point to the ring-anode A. The output is taken off where shown.

In operation the electrons emitted, say, from the cathode C produce a current in the coil L, and the resulting voltage accelerates the stream through the tube so that it reaches the second cathode C1 with sufficient speed to produce secondary electrons, which are then similarly accelerated back to the first cathode C. The process is repeated until the oscillations build up to the saturation limit of the tube.

Farnsworth Television Inc. Convention date (U.S.A.) July 5th, 1934. No. 451724.

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TELEVISION

WITH spot-light scanning, it is usual to employ either a single photo-electric cell, or a bank of cells, all of which pick up the reflected light from the object to be televised. When a single cell is used it is difficult to obtain a uniform "pick-up" over the whole of the field of view, whilst when several cells are employed simultaneously the distribution of light and shade is not satisfactory.

According to the invention several cells are arranged so that one (or more) is always in circuit, but not all of them at any one time. The cells are arranged at different points around the object to be transmitted, and are cut in and out of circuit, as the circumstances require, by means of a suitable commutator interposed between them and the common amplifier.

Marconi's Wireless Telegraph Co., Ltd., and H. M. Dowsett. Application date January 16th, 1935. No. 450413.

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ENLARGING THE PICTURE

IN order to provide an inexpensive lens arrangement for enlarging the picture produced on the fluorescent screen of a cathode-ray tube, the end of the tube is either made as, or is backed by, a lens, which has a plane surface facing the picture and a concave surface facing the viewing screen on to which the enlarged picture is to be projected. Interposed between the plane-concave lens and the final screen is a simple convex lens or objective. The combination automatically corrects for field curvature even when projecting on to a comparatively large screen.

Telefunken Ges. fur drahtlose Telegraphie m.b.h. Convention date (Germany) January 30th, 1935. No. 453043.

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CATHODE-RAY TUBES

A PROBLEM which arises in connection with highly-evacuated tubes is the tendency for electric charges to accumulate on the fluorescent screen, and by their action on the electron stream to distort the built-up picture. It has been proposed to overcome this by interposing between the "gun" and the screen a metallic layer which acts as a Lenard window, so that the picture can be seen from the other or far side. It is not easy, however, to discover a suitable metal for this purpose.

According to the invention a metal of "low electron withdrawal energy" is employed. That is to say, a metal having secondary emitting properties of the order of those of potassium, caesium, and magnesium. A small bead of the metal is initially placed inside a small branch formed in the side-wall of the cathode ray tube, and is "pointed" towards the fluorescent screen, so that when heated a very thin layer is deposited over the screen. The operation serves at the same time to "getter" or increase the degree of vacuum inside the bulb by driving out residual molecules of gas.

Telefunken Ges. fur Drahtlose Telegraphie. Convention date (Germany) February 2nd, 1934. No. 451590.