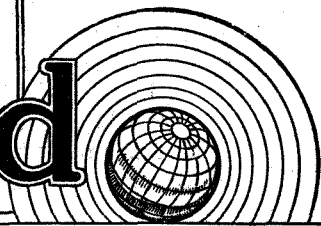
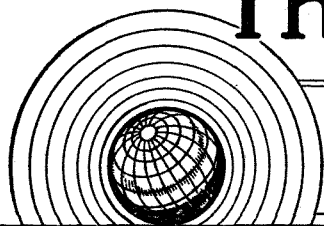


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*As many of the circuits and apparatus described in these
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EDITORIAL COMMENT

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—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 crossroads 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 charac-

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.

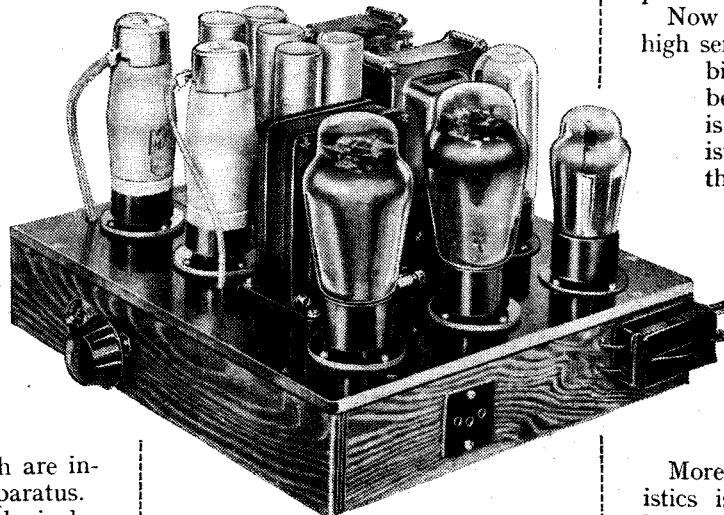
Now the pentode has the advantage of high sensitivity, a comparatively low grid bias and higher efficiency, and it is because of these advantages that it is so widely used. Its characteristics are not nearly as straight as those of a triode, however, and as the load impedance must be much less than its 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.

teristics 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

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 trans-

former secondary and the output transformer primary would be $\mu RL / (Ra + RL)$, where μ and Ra are the amplification factor and AC resistance respectively of the valve and RL 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 $\mu RL / \{Ra + RL + R(1 + \mu)\}$. The gain is reduced in the same proportion as if the valve resistance were increased from Ra to $Ra + R(1 + \mu)$.

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 Ro 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 Ro would obviously be $R + Ra$, 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.

change in anode voltage is thus less than it would be if feed-back were absent, and the effective output resistance is higher. Actually $Ro = Ra + R(1 + \mu)$.

This circuit is consequently of use only when the high value of Ro 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

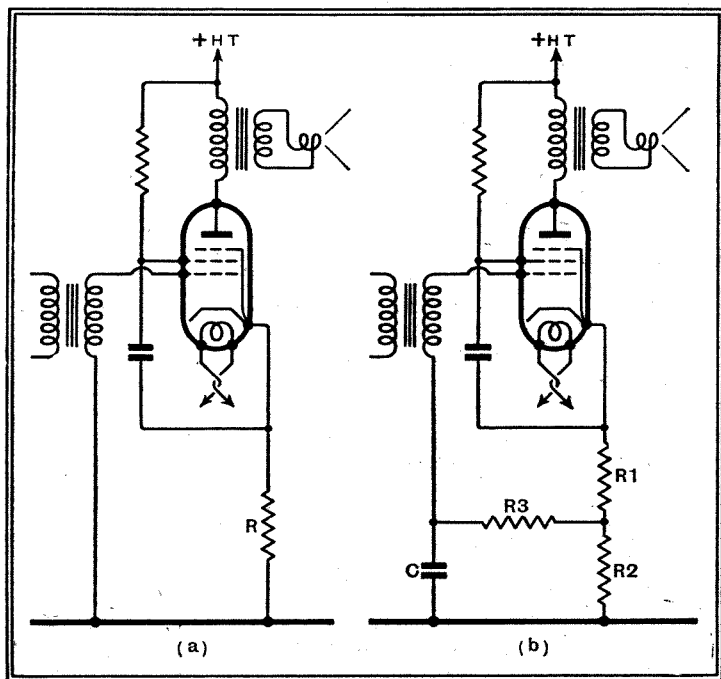


Fig. 1.—Negative feed-back is most readily applied by omitting the usual by-pass condenser across the bias resistance R as shown at (a). A greater amount of feed-back can be secured by adopting the connections of (b).

former secondary and the output transformer primary would be $\mu RL / (Ra + RL)$, where μ and Ra are the amplification

potential tends to reduce the anode current and so offset the original increase. The change in anode current for a given

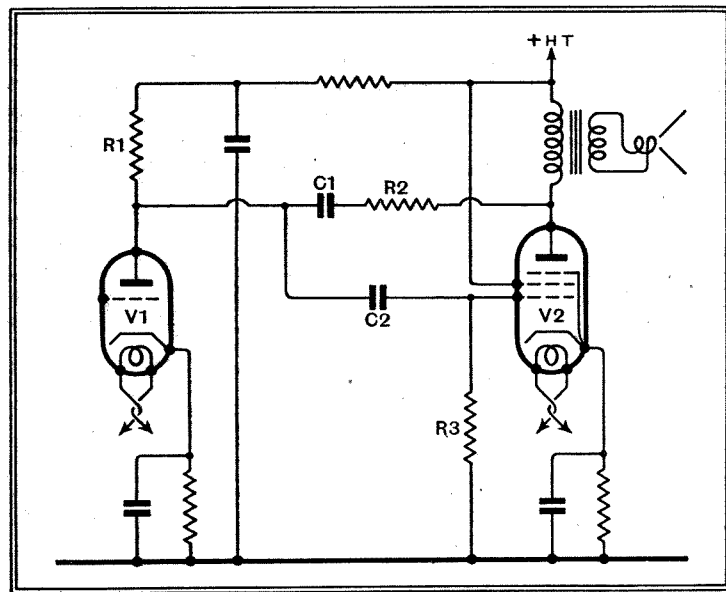


Fig. 2.—A feed-back circuit which has the advantage of greatly reducing the apparent AC resistance of the output valve. As explained in the text, this circuit is unsuitable for general use.

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 R_3 can be assigned arbitrary values of some 2 mfd. and 50,000 ohms while in the equations $R = R_1 + R_2$. Only R_1 is effective for producing grid bias, however.

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 C_1 and R_2 . Actually C_1 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 R_2 at the lowest frequency required.

Circuit of Low Output Resistance

Actually, this resistance R_2 forms a potentiometer across the output with the resistance of V_1 , R_1 , and R_3 all in parallel. The proportion of the voltage developed across the output transformer which is fed back to the grid is $R / (R + R_2)$ 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.

Negative Feed-back Amplifiers—

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 V_1 , 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

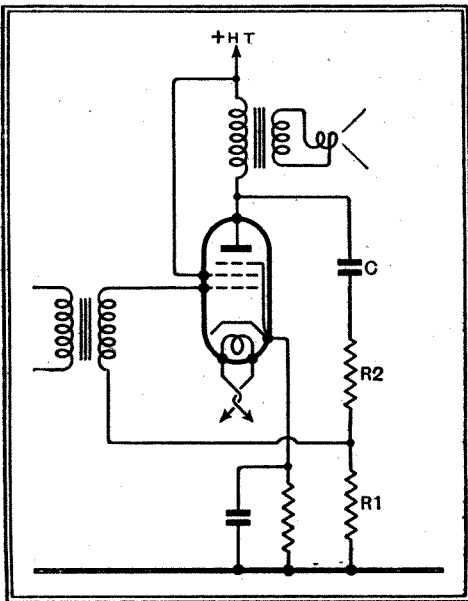


Fig. 3.—A practical circuit giving all the advantages of negative feed-back and a low output impedance.

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.

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 R_2 we have to decide on R_o and fix an arbitrary value for R_1 . 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.

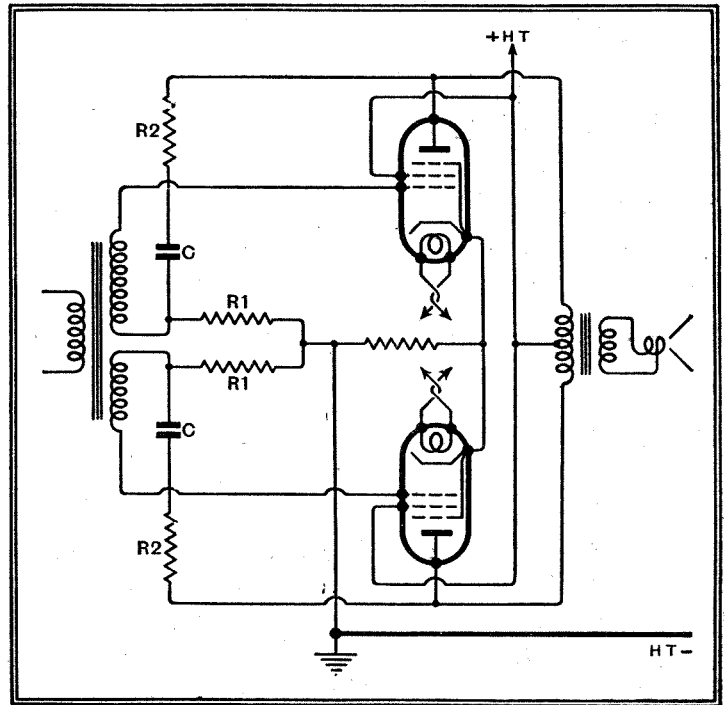


Fig. 4.—The circuit of Fig. 3 applied to a push-pull amplifier necessitates the use of an input transformer with a split-secondary. It is sometimes necessary to shunt the secondaries with high resistances to maintain an even frequency response.

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 R_1 and R_2 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

Negative Feed-back Amplifiers—

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.

what they should so long as a limitation of 100 kilowatts is imposed.

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 Alsations. 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.

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 Klaipéda? 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 Klaipéda 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



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.

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 speaker¹ 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,

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

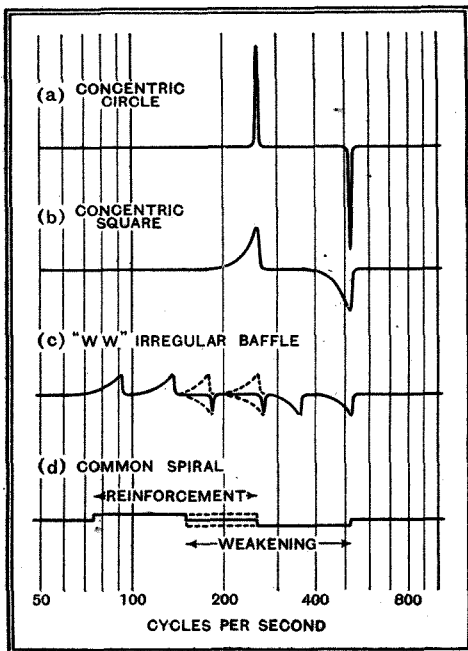


Fig. 1. Diagrammatic response curves showing the interference effects in baffles of various shapes. For simplicity the bass cut-off has been ignored.

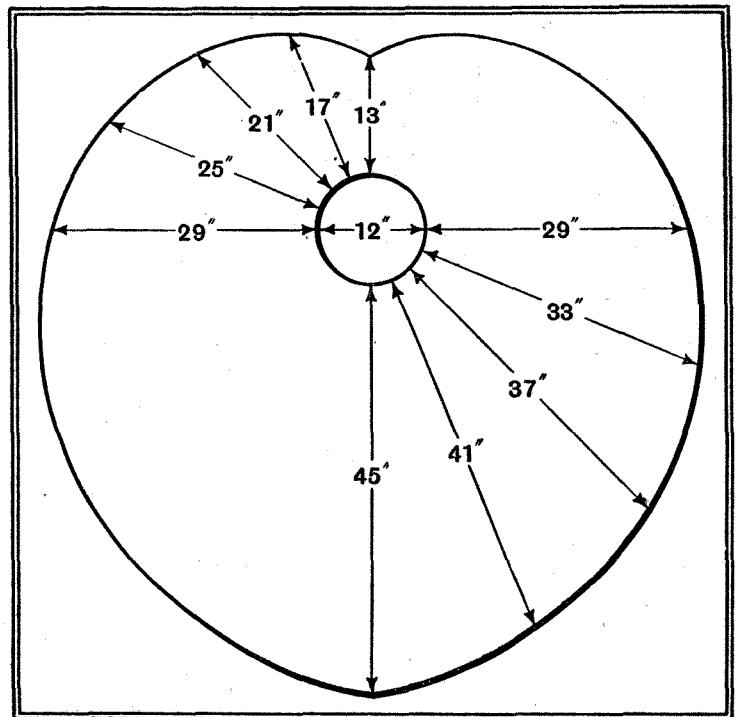


Fig. 2. Suggested heart-shaped baffle developed from two common spirals.

subtend the same total angle at the centre, whatever d may be.

If the spiral runs from a minimum of 13 in. from the cone out to a maximum of 45 in., 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.