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.

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EDITORIAL COMMENT

Interference Suppression

France Sets an Example

IT is a curious paradox that although of all European countries France has been one of the slowest to develop an efficient broadcasting service, yet France is leading the way in the matter of control of interference affecting reception.

It would almost seem as if France has taken the view that the French public ought not to be expected to contribute to broadcasting in the form of paying a licence until proper steps have been taken to clear the ether of interference as far as possible.

Defining Interference

Whilst in this country and elsewhere experts are still arguing as to what constitutes interference, France has made a decision. In the new law just published in the official journal it is laid down that interference comes within the law when it reaches a value equivalent to a field strength of 1 millivolt per metre or more, and further that the interference must be of a duration not less than three seconds and recurring at intervals of greater frequency than 10 minutes.

Another interesting decision of the French Government in promulgating this law is that from October 1st, 1934, all electrical apparatus sold to the public must carry a label indicating whether or not the equipment has been rendered interference-free, in order that the purchaser may be well aware of the risk he runs of causing illegal interference if he uses apparatus which radiates.

Elsewhere in this issue we print a statement from the Institution of Electrical Engineers concerning the work of the Radio Interference Committee. It is pointed out that the Committee has found that it will be essential "to agree some standard of interference which on the one hand will represent substantial immunity for a well-designed radio set, and on the other hand is demonstrated as being of practical application to electrical appliances which emit interference, and to radio sets which are subject to such interference."

From reading the I.E.E. statement in detail it would seem to us that the Committee is influenced too much by the representatives of the electrical industry and that the radio public is not receiving adequate consideration. It cannot be right that legislation should be introduced which would require that hundreds of listeners in a given area should be obliged to fit additional apparatus to their receivers to remove interference which could be far more effectively suppressed at the source at a fraction of the cost which would devolve upon the public to remove such interference individually at their receiving sets.

I.E.E. Committee and the Public

Too much attention seems to be directed towards putting the onus upon the individual listeners, when suppression of the interference at the source is the proper and obvious remedy.

If the Institution Committee will only insist upon putting the public interest first, we feel sure that they will in the long run be acting in the best interests of Institution members. This Committee has been set up on a suggestion from *The Wireless World* to consider a matter of public concern and it would indeed be deplorable if its ultimate findings indicated that it had been serving "party" interests instead.

High Quality Amplification

Designing Distortionless Apparatus

In the reproduction of music and speech for entertainment purposes the attainment of a high standard of fidelity is of paramount importance, and with suitable equipment it is possible for this to be so high that it is easy to mistake the reproduction for the original. For this desirable effect to be achieved in practice it is necessary for distortion to be considerably lower than the level usually tolerated, and special precautions have to be taken throughout the apparatus. In this article the chief sources of distortion are discussed together with those arrangements which are inherently the most free from undesirable effects, and which are consequently the most suitable for high quality reproduction.

By W. T. COCKING

BROADCASTING and gramophone records are used chiefly for entertainment purposes, the aim being to reproduce in the listener's own home exactly what he would hear if he were in the studio. Unless the sound output from the loud speaker is identical with that in the studio, the reproduction cannot be said to be distortionless. In many aspects of wireless, of course, distortion is not thought of great importance, and most commercial services are considered satisfactory as long as speech is intelligible. Mere intelligibility is far below the requirements of broadcasting, however, and a very high degree of freedom from distortion is necessary if the reproduced version of an orchestra is to bear any great resemblance to the original.

In the link between the studio and the listener's room a very large amount of apparatus is involved, and in the last resort there is none of it which can be truly said to introduce no distortion at all. Properly designed and operated equipment, however, need cause only a minute amount of distortion, and for most practical purposes can be called distortionless.

We need not here concern ourselves with the transmitting side in the case of broadcasting, or the recording difficulties in the case of gramophone records. It is of more practical moment to deal with the apparatus under our immediate control, namely, the reproducing equipment, and of this only a part can be considered at the moment. This part is the low-frequency amplifier, and includes all the apparatus between the detector, or the gramophone pick-up, and the loud speaker.

Frequency Response

There are three types of distortion which such apparatus may introduce—amplitude, frequency, and phase distortion. Amplitude distortion occurs when the amplification is a function of the input voltage. Actually, its effect is to introduce alien frequencies which are multiples of the input frequency. It always occurs if the input is greater than that for which the apparatus is designed, and it is responsible for much of the harsh and rasping reproduction that is heard. Frequency distortion means merely that the amplification is a function of frequency, so that all notes are not amplified equally.

The ear is very accommodating with respect to this type of distortion, and large departures from the ideal condition are possible without any noticeable effect.

For perfect reproduction all frequencies between 25 and 20,000 cycles must be amplified equally. No broadcasting station, however, transmits frequencies above some 10,000 cycles, and few gramophone records contain frequencies above 6,000 cycles. Moreover, experiments have indicated that the range of 25 to 10,000 cycles gives reproduction so natural that it is very difficult to detect the absence of higher frequencies, and their absence is probably noticeable only on certain noises as distinct from musical sounds. We may say, therefore, that practical perfection is reached with a uniform response between 25 and 10,000 cycles.

The response, however, need not be entirely uniform, for the ear cannot detect small changes in volume. With a rapid comparison of a single note the ear cannot detect a change of less than about 1 db. Where the comparison is between notes of different frequency the ear is much less sensitive, for the sensitivity of the ear itself varies greatly with frequency. It is not too much to say that a variation in amplification of 5 db. at the extremes of the frequency scale would not be detectable on either speech or music. For practical perfection, therefore, the overall response of the apparatus should not vary more than 5 db. over the whole range of 25 to 10,000 cycles. Ordinary equipment, of course, gives a much greater variation, and there is often a loss of over 40 db. at the highest frequency.

Amplitude Distortion

Amplitude distortion is more difficult to specify in figures but it is usually taken that 5 per cent. harmonic content is permissible, and the output of a valve is rated on this basis. Assuming for the moment that this figure is correct, although the writer is inclined to think it too high for the best quality, it must not be forgotten that if we choose every valve in the receiver on this basis the total distortion will be much greater. If we require only 5 per cent. total distortion we can choose the output valve on a basis of 5 per cent. distortion only if the distortion in all the other equipment is zero. This will never be the case, so that where first-class reproduction is needed it is necessary to design every stage for minimum distortion.

Amplitude distortion occurs chiefly in valves, and when the valve is acting as an amplifier the distortion is smallest for a small input. It is, however, never quite zero, although it may be negligibly small. This form of distortion may also be introduced by transformers and iron-cored chokes, for, like valves, the characteristics of iron are non-linear. The distortion may be reduced to a very small quantity by the correct design of the components, but the simplest course is to eliminate it wherever possible by using components which do not involve iron cores. Resistance coupling, therefore, is the most inherently free from amplitude distortion.

The question of frequency distortion is not difficult, and it is not unduly troublesome to obtain an even response with either transformer or resistance coupling, but greater freedom in design is possible

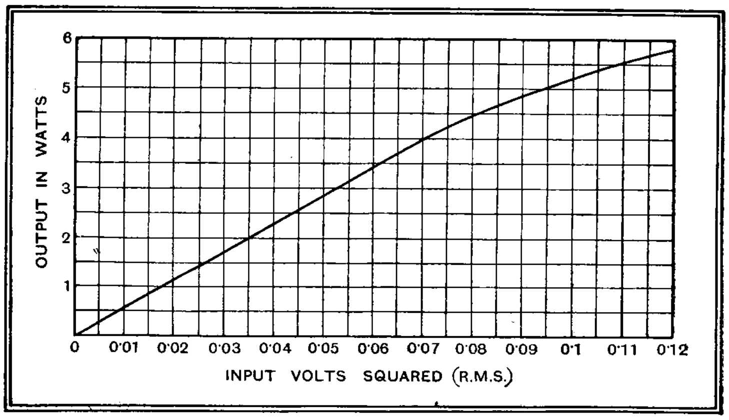
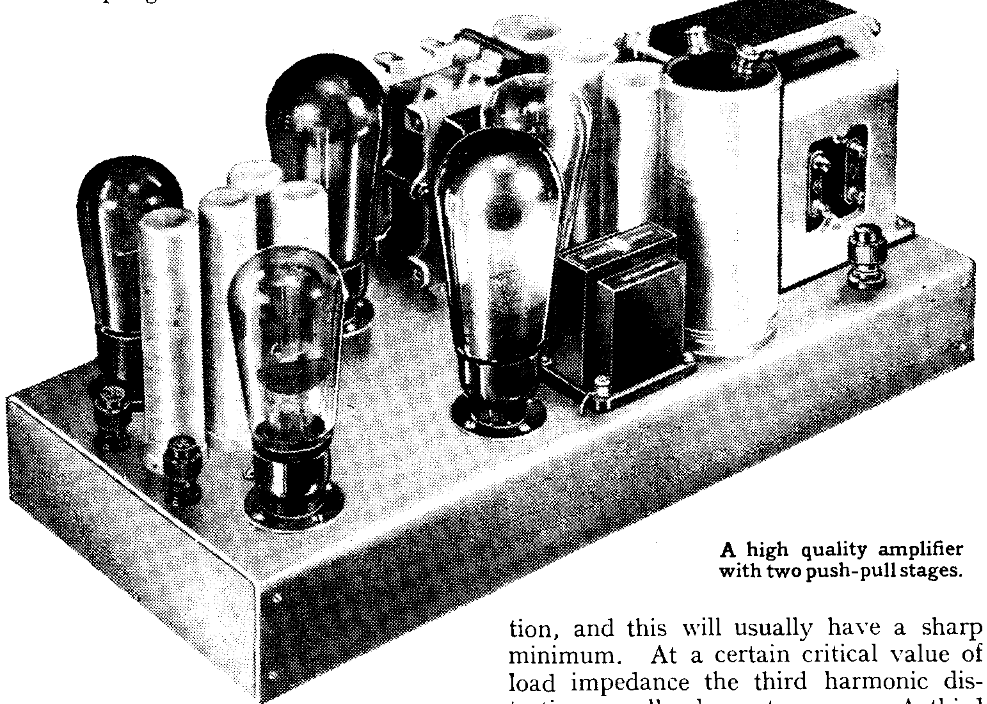


Fig. 1.—This curve shows the relationship between the square of the input voltage to the amplifier and the power output. It is a straight line for outputs up to 4 watts, indicating distortionless amplification. The distortion at 6 watts, however, is quite small.

High Quality Amplification—
with the latter. Although phase distortion is usually considered to be unimportant in sound reproduction, it is doubtful if this has been definitely proved, and in any case it plays an important part in television. While not so important as other forms of distortion, therefore, it is desirable that it be kept at a minimum. As a result there is no real alternative to resistance coupling, for it is difficult to avoid severe phase distortion with transformers. It will be seen, therefore, that resistance coupling is the most suitable for a high-quality amplifier.



A high quality amplifier with two push-pull stages.

Pentodes v. Triodes

Returning to the question of amplitude distortion, we can use triodes or pentodes alone, in parallel, in push-pull, or in parallel-push-pull, in the output stage. Since connecting two valves in parallel is the same as using one of half the resistance, our effective choice is between triodes and pentodes alone or in push-pull. In a triode the distortion is chiefly due to the introduction of a second harmonic, and higher harmonics are negligible in comparison. If we plot a curve showing the relationship between the percentage distortion and the power output, this will gradually rise from small outputs until the rated power for five per cent. distortion is reached. For higher outputs, the curve will usually rise more rapidly. A very similar curve will be found for the total distortion in a pentode, but the distortion may be either second or third harmonic or a combination of both.

Suppose now that for a certain output we plot a curve showing how the distortion varies with the load impedance on a triode valve. There will be a certain value of load impedance for which the distortion is a minimum, and although this optimum load impedance is well defined, it is not very critical, and quite large changes make only a small difference to the distortion. It must be remembered that the distortion is almost entirely due to the introduction of a second harmonic.

Now let us consider the pentode. The curve showing the relationship between second harmonic distortion and load impedance will be similar to that for a triode. Another curve can be drawn, however, showing third harmonic distortion, and this will usually have a sharp minimum. At a certain critical value of load impedance the third harmonic distortion usually drops to zero. A third curve showing total distortion gives another optimum load impedance. With a pentode, therefore, there are three different load impedances which we might use, according to circumstances. There is one load giving minimum second harmonic distortion, another giving zero third harmonic, and still another giving minimum total distortion. In general, each of these impedances is more critical than in the case of a triode.

Before deciding between a triode and a pentode, let us consider the relative advantages of a single large valve and two smaller ones in push-pull, for even harmonics are largely balanced out by the push-pull connection. With two triodes in push-pull, therefore, second harmonic distortion is negligible and the overload point is determined by the appearance of third harmonics when the output is such that the second harmonic *per valve* is much greater than five per cent. Two triodes in push-pull, therefore, will give more than twice the output of a single similar valve for the same total distortion. Of even greater importance, however, is the fact that up to the normal output per valve the distortion is negligible in a reasonably well-balanced stage, whereas it is not with a single valve.

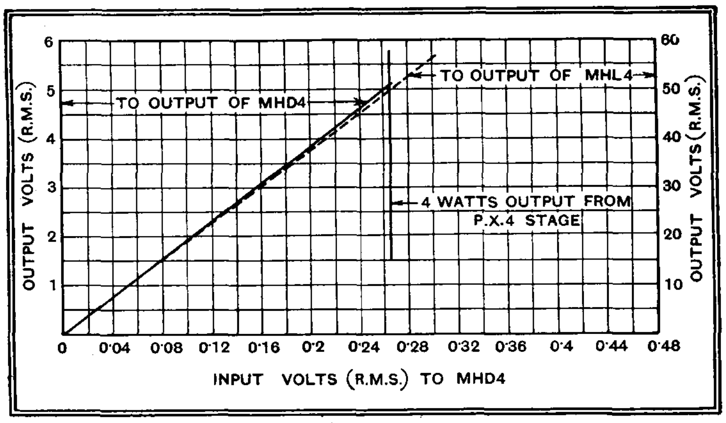


Fig. 2.—One curve indicates the input/output characteristics of the first amplifier stage, while the other gives the same information for the first two stages together. Both curves are straight lines for inputs below 0.265 volt R.M.S.

Now let us consider the question of using pentodes in push-pull, and as third harmonic distortion cannot be balanced out it is obvious that we should choose the load impedance giving zero third harmonic distortion. Since the push-pull connection will eliminate the second harmonic distortion, this load impedance should become the optimum for a push-pull stage, and freedom from both second and third harmonic distortion should be obtained.

The Load Impedance

On the data at present available we have no grounds for a choice, for one important factor has been omitted. In practice the load impedance on the output stage is not constant, for it varies greatly with frequency. It is, therefore, impossible to work with the optimum load impedance at all frequencies unless compensating devices are used. Ignoring these for the moment, it will be remembered that the pentode is much more critical in the matter of load impedance than the triode, consequently the distortion introduced by the lack of constancy in the impedance of the loud speaker will be the greater with the pentode. It is true that compensating circuits can be devised to maintain the load on the output stage more nearly constant, but these are usually tricky in their adjustment and often give a loss of power.

Another aspect of the matter is worthy of mention. No loud speaker is completely free from resonances, and it is possible to reduce these by damping the speaker electrically. This is effected by the transferred valve resistance being effectively in parallel with the speech coil, and this is much lower in the case of a triode than with a pentode. An example may make the matter clear. Assume that we have a speech coil of 8,000 ohms impedance and we use it with a 1-1 ratio output circuit. Correct matching with a triode will be secured when the valve has a resistance of some 3,000 ohms, so that the damping on the speaker is due to a shunt resistance of 3,000 ohms. Now

High Quality Amplification—

with the average pentode the 8,000 ohms impedance of the speech coil gives correct matching, but the A.C. resistance of the valve is some 30,000/60,000 ohms, so that the speaker is damped much less heavily. Resonances, therefore, will be more prominent with the pentode than with the triode.

It will be clear, therefore, that the ideal output stage for present types of loud speaker is a pair of triodes connected in push-pull. It is not sufficient, however, to reduce the distortion in the output stage to a minimum, and just as much care must be given to the design of the earlier stages. Since resistance-capacity intervalve coupling is to be used, it is hardly possible to use a single valve to feed the output stage, for the distortion in this penultimate stage would exceed that of the output valves. Push-pull must be used here, therefore, but as this stage requires only a moderate input it may be fed without distortion from a single valve if care be taken to choose the operating conditions correctly.

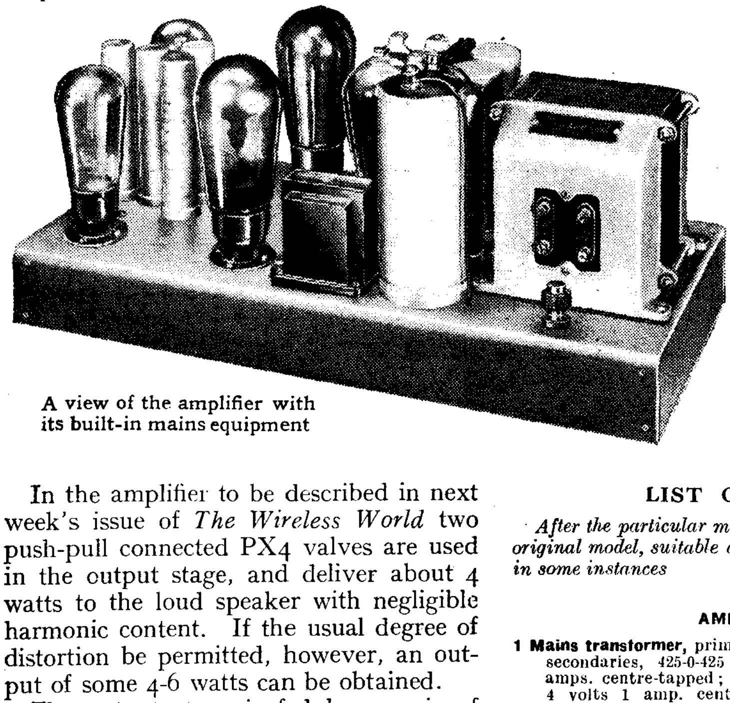
The degree of linearity obtainable by following the procedure laid down in this article is well brought out by the curves of Figs. 1 and 2. Fig. 1 shows the relationship between the square of the input voltage and the power output of an amplifier, full details of which will be given next week. It is a straight line up to the maximum output of 4 watts, but after this the overload point is reached. Fig. 2 shows the linearity of the individual stages, one curve showing the relationship between input and output volts for the first triode, which has a load impedance of 100,000 ohms, and the other the relationship between the input to the amplifier and the input to the output stage. Both curves are straight for inputs exceeding that for 4 watts output, showing that the non-linearity of the whole amplifier at outputs over 4 watts is due entirely to the output stage, as it should be.

In Next Week's Issue :—

PUSH-PULL QUALITY AMPLIFIER

Quality Apparatus for Sound Reproduction and Television

THE highest standard of reproduction demands a flat overall characteristic up to about 10,000 cycles with a very low limit of amplitude distortion, while for television purposes a minimum of phase distortion is also important. These requirements are best met by a resistance-capacity coupled push-pull amplifier.



A view of the amplifier with its built-in mains equipment

In the amplifier to be described in next week's issue of *The Wireless World* two push-pull connected PX4 valves are used in the output stage, and deliver about 4 watts to the loud speaker with negligible harmonic content. If the usual degree of distortion be permitted, however, an output of some 4-6 watts can be obtained.

The output stage is fed by a pair of MHL4 valves, also connected in push-pull, and the necessary phase reversal for their operation is obtained from the single valve used in the feeder unit. In order to obtain the full 4 watts output an input to the first valve of no more than 0.265 volt R.M.S. is needed.

Hum is inaudible and provision is made for energising a speaker field. Although the equipment described is primarily intended for gramophone work, provision is made in the design for using it with radio receivers, and the mains equipment is capable of providing 260 volts at 40 mA. for its operation, together with 4v. A.C. at 5-6 amperes.

Measurements have shown complete linearity up to an output of 4 watts, and that the frequency response is flat within 1.2 db. over the range of 20 to 10.000 cycles.

LIST OF PARTS

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

AMPLIFIER

1 Mains transformer, primary, 200 to 250 volts, 50 cycles; secondaries, 425-0-425 volts, 120 mA.; 4 volts 2.5 amps. centre-tapped; 4 volts 1 amp. centre-tapped; 4 volts 1 amp. centre-tapped; 4 volts 7/8 amp. centre-tapped **Sound Sales Type PP/QA**
(B.S.R., British Radio Gramophone Co., Bryce, Challis, Heayberd, Claude Lyons, Parmeko, R.I., Rich and Bundy, Varley, Vortexion, Wearite.)
1 Smoothing choke, 7/30 henrys at 120 mA, 215 ohms **Ferranti B2**
1 Smoothing Choke, 20 henrys at 50 mA., 400 ohms **R.I. "Hypercore"**
(Alternatives same as mains transformer above)
3 Electrolytic condensers, 8 mfds., 500v. peak **Dubilier 0281**
1 Fixed condenser, 4 mfds., 450v. working, cylindrical container **Dubilier LEG/9204**
2 Electrolytic condensers, 4 mfds., 500v. peak **Dubilier 0283**
(Ferranti, Peak, T.C.C.)
2 Electrolytic condensers, 50 mfds., 50v. peak **Dubilier 3003**
2 Electrolytic condensers, 200 mfds., 10v. peak **Dubilier 0283**
(T.C.C.)
2 Fixed condensers, mica, 0.1 mfd. **Dubilier B775**
(T.C.C.)
2 Tubular paper condensers, non-inductive, 0.05 mfd. **Dubilier 4403**
(Graham-Farish, Peak, T.C.C., T.M.C.Hydra)
2 Resistances, 1,000 ohms, 2 watts **Claude Lyons**
2 Resistances, 100 ohms 1 watt **Claude Lyons**
2 Resistances, 1,000 ohms 1 watt **Claude Lyons**
2 Resistances, 5,000 ohms 1 watt **Claude Lyons**
2 Resistances, 10,000 ohms 1 watt **Claude Lyons**
2 Resistances, 25,000 ohms 1 watt **Claude Lyons**
2 Resistances, 250,000 ohms 1 watt **Claude Lyons**
2 Resistances, 500,000 ohms 1 watt **Claude Lyons**
(Dubilier, Erie, Ferranti, Graham-Farish, Seradex, Watmel)
7 Valve holders, 5-pin **Clix Chassis Mounting Standard Type**
1 5-pin plug **Bulgin**
(British Radio Gramophone Co.)
3 Ebonite shrouded terminals, Input (2), Earth (1) **Belling-Lee Type "B"**
1 Metal Chassis **C.A.C.**
Valves:—2 Marconi or Osram MHL4; 2 Marconi or Osram PX4; 1 Marconi or Osram MU14

FEEDER UNIT

1 Electrolytic condenser, 8 mfds., 500 volts peak **Dubilier 0281**
(Ferranti, Peak, T.C.C.)
1 Electrolytic condenser, 50 mfds., 6 volts peak **Dubilier 3001**
(T.C.C.)
1 Resistance, 7,500 ohms 10 watts **Dubilier "Spirohm"**
(Bulgin)
1 Resistance, 2,000 ohms 1 watt **Claude Lyons**
3 Resistances, 50,000 ohms 1 watt **Claude Lyons**
(Dubilier, Erie, Ferranti, Graham-Farish, Seradex, Watmel)
1 Tapered volume control potentiometer, 250,000 ohms, with knob **Ferranti Type "P"**
(Claude Lyons, Magnum, Rothermel)
1 Valve holder, 5-pin **Clix Chassis Mounting Standard Type**
1 5-pin plug **Bulgin**
(British Radio Gramophone Co.)
1 5-way cable with twin 70/36 leads **Harbros**
(Goltone)
4 Ebonite shrouded terminals, Output (2), Input (2) **Belling-Lee Type "B"**
1 Metal chassis **C.A.C.**
Valves:—1 Marconi or Osram MH4

Interference With Radio Reception

THE Institution of Electrical Engineers' Committee on Radio Interference has issued the following statement:—

The Committee find it desirable to establish, in the first place, practical methods and instruments for appraising the interference and the apparatus causing it. With this end in view it has been found essential to agree some standard of interference which, on the one hand, will represent substantial immunity for a well-designed radio set, and, on the other hand, is demonstrated as being of practical application to electrical appliances which emit interference, and to radio sets which are subject to such interference.

The attention of the Committee is further being actively directed along two channels:

(1) A study of methods and devices, and their effectiveness, which are within the power of the radio listener to apply, for ameliorating the effects of interference.

(2) A study of methods and devices for suppressing the emission of interference from electrical apparatus.

The interests represented on the Committee are co-operating actively to resolve all these questions as a necessary preliminary to making recommendations.

The Committee note with satisfaction various constructive efforts to help forward a better understanding of the problem, and practical steps for ameliorating the trouble. They think it well, however, to call attention to the fact that there are phases of the problem yet to be solved.

Single-Span Dissected

Simplified Diagrams Explaining the New Tuning System Step by Step

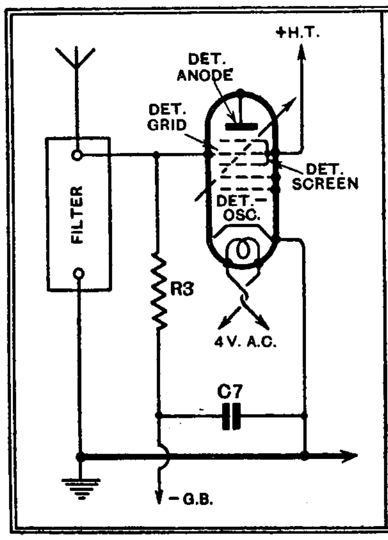


Fig. 1.—The input filter circuit.

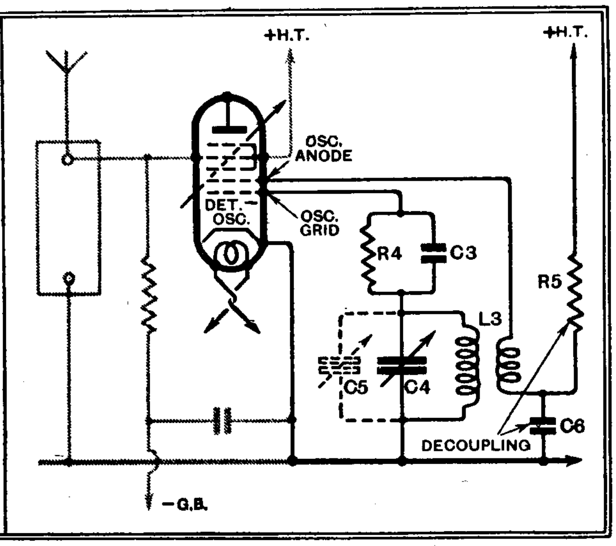
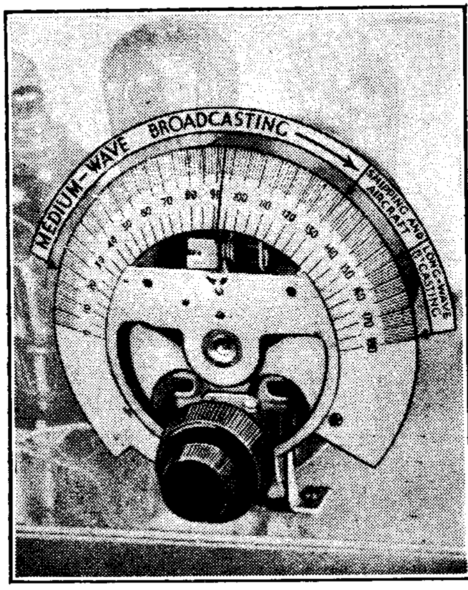


Fig. 2.—Oscillator circuits of the frequency-changer valve.



A typical "Single-Span" tuning scale. Although the long-wave section may appear to be crowded, these stations actually have their full share of space.

ALTHOUGH the Single-Span receiver recently described in these pages is simpler than a conventional A.C. superheterodyne, the circuit diagram appears to be complicated unless considered in stages. A study of this series of dissected diagrams will explain the functioning of the new system from an essentially practical point of view.

Fig. 1.—Signals at all broadcasting wavelengths are applied to the detector grid of the frequency-changer valve through a special input filter; all lower wavelengths which might cause second-channel interference are cut off. Negative bias for anode-bend detection is applied through R3.

Fig. 2.—A tuned circuit covering wavelengths between about 100 and 170 metres (1,750-3,100 kc/s) is connected across the oscillator grid circuit of the valve, negative bias being produced by the action of R4 and C3. The oscillator anode circuit is completed through a reaction coil. Locally generated oscillations and those of the chosen wavelength from the aerial combine in the valve to produce a "beat" at nearly 190 metres wavelength (1,600 kc/s).

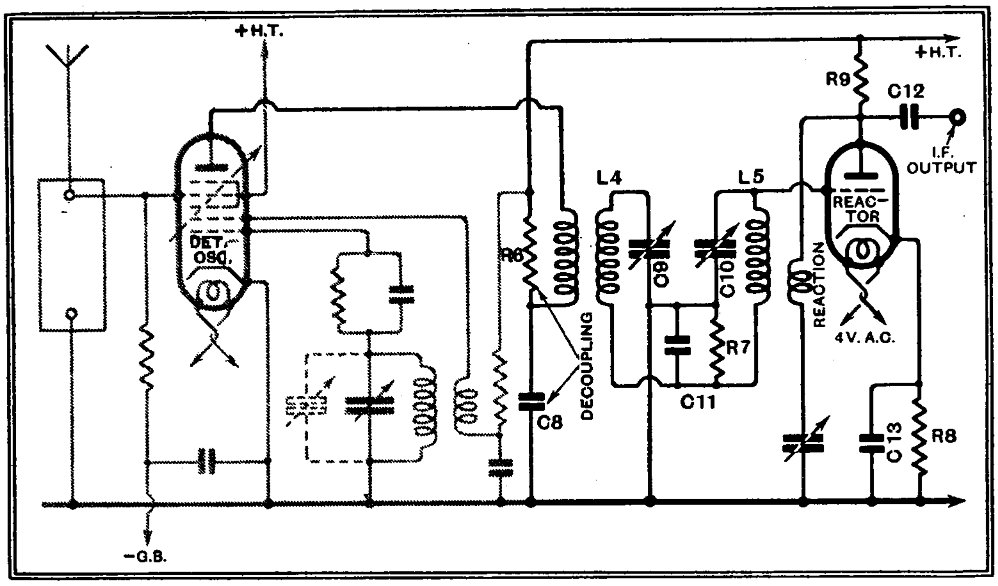


Fig. 3.—Intermediate-frequency impulses are applied to the reactor valve.

Fig. 3.—Signals of this new frequency are applied through the I.F. filter network to the grid of the reactor or buffer valve. Selectivity, and to a lesser extent sensitivity, are determined by the amount of reaction applied between grid and anode circuits of this valve.

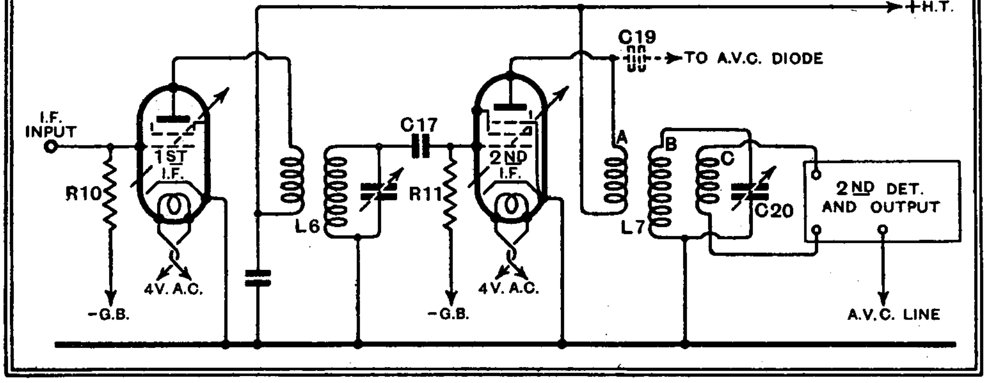


Fig. 4.—Intermediate-frequency amplifier and second detector-output connections.

Fig. 4.—The intermediate frequency output from the reactor valve is passed to a straightforward two-stage I.F. amplifier by resistance coupling, and after amplification, to a second detector and output stage of conventional design. Arrangements are made to feed back A.V.C. voltages to the grids of the detector-oscillator and the first I.F. amplifier.

UNBIASED

By FREE GRID

Confined his lethal activities to wasps.

Summer-y Justice

ONE of the hardiest of annuals in the realms of invention is undoubtedly the death ray. It seems to recur with almost monotonous regularity, and I see by my morning paper that it is being served up to us once again. In this instance, however, the claims of the inventor are singularly modest as, so far, he has confined his lethal activities to wasps, flies and mice.

Still, even if it can only eradicate these pests, his invention should be a boon and a blessing to man, and I am glad to see that this point is appreciated by a well known preserve-making firm who have approached the inventor with a view to securing summary execution of the wasps which keep buzzing round their strawberry jam. Unfortunately, the range and scope of the apparatus seems limited, as it is necessary to place the wasps carefully between two copper plates.

I cannot help thinking that the time taken by the executioner in catching each wasp and placing it carefully between the two plates might be more profitably occupied by swatting it in the conventional manner. In fact, I am reminded of how I was duped years ago by an astute merchant who advertised a patent wasp killer, guaranteed to get its man every time. I sent up my guinea in high hopes and by return of post received two largish blocks of wood marked A and B. "After catching the wasp," ran the accompanying instructions, "place it carefully on Block A and press Block B firmly on top of it."

Why Not Llanfairpwllingogwgoch ?

FROM what I hear, the booklet containing "recommendations" concerning the pronunciation of Welsh place names has been productive of a great deal of unrest among the B.B.C. announcers, racial feeling having been aroused over the matter.

On the one hand, those who, like myself, have a certain percentage of Welsh blood in their veins, are righteously incensed at the outrage committed upon their natural patriotic feelings by a committee whose knowledge of Welsh names seems to have been derived from association with coloured seamen in Cardiff docks. On the other hand, the non-Celtic members of the announcing staff not unnaturally feel that they would endanger their dentures if they attempted to follow the advice of the committee.

Speaking as one who has some knowledge of the language, I must, however, point out that the danger would be no less even if the names were properly pronounced, and in any case the risk of laryngeal dislocation is no greater when pronouncing the Polish name of Szczebrzeszyn (which announcers frequently do) than in tackling our old friend Llanfairpwllingogwgoch, which, by the way, the committee obviously funked, as I can find no trace of it in their precious booklet.

I feel sure that as soon as these recommendations are put into practice ill-feeling will spread to the Welsh-speaking and the more civilised inhabitants of these islands. The former will naturally be displeased at the hideous mangling of their euphonious tongue, and the latter incensed at the apparent ineffectiveness of the devices which they have been inveigled into buying for the suppression of electrical interference.

As usual, the rôle of peacemaker and general problem-solver falls to me, and after much thought I have evolved a scheme which will not only prevent trouble but stimulate trade.

Briefly, my proposal is that Welsh and other foreign names of an unpronounceable type should be televised. By this process much heart-burning would be averted and public interest in television would be stimulated. This, in its turn would

Risk of laryngeal dislocation.

save many of our manufacturers from threatened bankruptcy and find a new use for the B.B.C.'s now scarcely-used 30-line transmitting apparatus.

Philomel

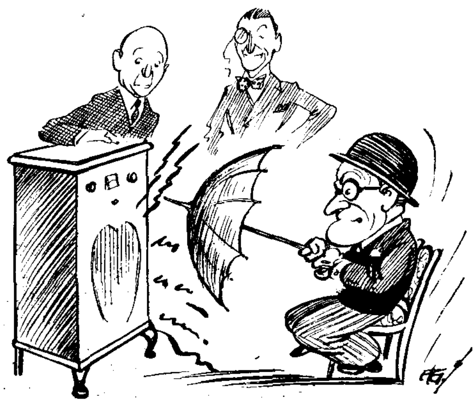
I AM heartily in agreement with the suggestion made by Mr. C. Tompsett in last week's issue to the effect that the B.B.C.'s new interval signal should consist of a recording of the nightingale.

There is, at any rate, no reason why the idea should not be given a trial. It would entail no expense to the B.B.C., as of course, they already possess an ample supply of nightingale records in the control room.

When a Noise Annoys

"WHAT noise annoys a noisy oyster most?" used to be a favourite wisecrack in the days of my youth, and apparently a somewhat similar question is troubling the minds of the committee set up some time ago by the I.E.E. to enquire into the causes and cure of various forms of electrical interference.

Everything has apparently gone smoothly with the enquiry, except that the committee cannot make up its mind as to what constitutes "an annoying noise." The reply to the original wisecrack used, I recollect, to be to the effect that a "*noisy* noise annoys a noisy



A truly appalling row.

oyster most," and I should have thought that this definition would have been good enough for this committee, but far from it. It is apparently quite unable to agree as to when a noise is noisy and annoying and when it is not, or in other words, what ratio to adopt between signal strength and interference.

I was quite unaware of these profound facts until a few evenings ago when I met a member of the committee at the house of a mutual friend. The wireless programme to which we were listening was almost blotted out at intervals by a truly appalling row, which was, our host told us, due to the efforts of a wretched woman next door who had invested in one of those diabolical contraptions known as an electric sewing machine.

My host and I naturally turned immediately to the committee man and asked what he and his colleagues were going to do about this sort of thing. To our surprise, however, he demurred, saying that in his opinion the offending noise was not nearly loud enough to be labelled as undesirable interference. Further questioned, he frankly confessed that the committee was undecided upon the question. In my opinion this disgraceful state of affairs can only be compared to the shilly-shallying of dentists, no two of whom are agreed as to what constitutes pain.

New System of Automatic Volume Control

Improving A.V.C. by I.F. Amplification

THE methods of obtaining automatic volume control are almost numberless and no system can in itself claim any great superiority over the others, for a choice depends largely upon the design of the receiver proper. Simple A.V.C. is now hardly ever used on account of the drop in initial sensitivity which it causes, and delayed systems are practically universal. In this article, a method is described whereby improved control is obtainable in a simple manner

ONE of the simplest automatic volume control systems is that known as delayed diode A.V.C.,[1] for two diodes can provide both signal rectification and automatic volume control, the components required are few in number, there is very little to go wrong, and there is a wide latitude in the choice of diodes. Two ordinary triodes can be used, a duo-diode, a duo-diode-triode, or a pair of Westectors.

The system, however, suffers from the disadvantage that for a wide range of control the delay voltage must be large, and this in turn means that the detector must be operated at a large input. When receiving a strong local station, in fact, the detector input will often be so large that the valve preceding the detector is overloaded, even if it be of the H.F. pentode type. A local-distance switch, therefore, is an essential feature of ordinary receivers incorporating this system of automatic volume control.

In order to overcome these difficulties a system involving the use of an additional valve operating as an anode bend detector[2] has been evolved and has been very widely used, particularly in America. This method of control is extremely satisfactory, and due to the gain obtained through the use of anode bend rectification as compared with diode detection, the A.V.C. bias voltage in the output is greater than the signal input. This, of course, is due to the rectifier acting to some degree as an amplifier also. Owing to the moderate input which it requires to produce a large bias, there is little risk of the last H.F. or I.F. amplifier valve being overloaded, even on a local station. Properly designed, an arrangement of this type can give very nearly perfect A.V.C., and it was employed in the A.V.C. Monodial Super.[3]

It is not without its disadvantages, however, the chief of which is the necessity for a source of potential negative with respect to the earth line of the receiver. This means, of course, that if the mains equipment is built on a separate chassis from the receiver there is a difference of potential of perhaps 100 volts between the two chassis, and if the apparatus be assembled in one unit difficulties arise in the mounting of electrolytic condensers. The provision of this voltage may in some cases prove difficult, for 100 volts is usually necessary for good operation and the avoidance of overloading in the A.V.C. valve itself. A further difficulty arises through the variations in the characteristics of different valves of the same type, which occur at their greatest in the region of anode current cut-off. The bias must normally be adjusted to be slightly higher than the figure which just cuts off the anode current, and it is found in practice that the bias voltage often requires readjustment when the A.V.C. valve is changed. Furthermore, the internal valve resistance is infinite with no applied signal, which means that the time constant of the circuit is high. As soon as a signal is tuned in of sufficient strength to operate A.V.C., of course, the time constant falls. The curious effect is obtained, however, of rapidly falling sensitivity on tuning in a station, but slowly rising sensitivity when tuning away from it.

These demerits of the system, however, are relatively unimportant when compared with the undoubted advantages which it has to offer, and the chief disadvantage is the necessity for a voltage supply negative with respect to the earth line. This point is usually sufficient to prohibit its use in a battery receiver.

The next system to appear for consideration is amplified A.V.C.[4] which would now be better termed D.C. amplified A.V.C. A duo-diode-triode valve is employed in which one diode acts as a detector, the triode provides amplification of the D.C. potentials, and the other diode provides the requisite delay. In addition to its functions in providing A.V.C., signal rectification and first stage L.F. amplification can also be obtained from the same valve. In the D.C. amplification, a stage gain of twenty times can readily be obtained, so that the detector input need only be one-twentieth of that necessary in a delayed diode system, and overloading of the preceding valve need hardly be considered. Practically perfect A.V.C. may be obtained with this arrangement, but if the valve is used also as an L.F. amplifier, considerable care in design is necessary to avoid distortion on a strong signal.

The arrangement is by no means as

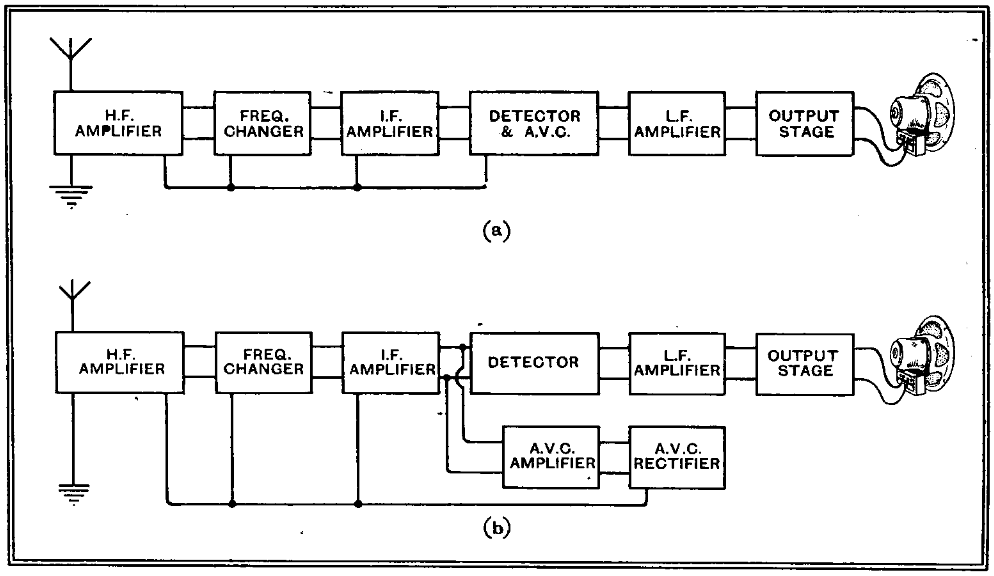


Fig. 1.—The schematic diagram of a superheterodyne fitted with delayed diode A.V.C. is shown (a) and the arrangement for I.F. amplified A.V.C. at (b).

1 *The Wireless World*, p. 208, Sept. 8th, 1933.
2 *The Wireless World*, Jan. 6th and 13th, 1933.
3 *The Wireless World*, March 17th and 24th, 1933.
4 *The Wireless World*, p. 244, September 22nd, 1933.

New System of Automatic Volume Control—

simple as that using a separate control valve, and it still necessitates a difference of potential between the earth line of the receiver and negative H.T., so that it offers no advantage in this respect, and its use in a battery receiver is usually impracticable. Although the arrangement is in many respects ideal, it has been found in practice to suffer from one serious disadvantage—its liability to cause an effect similar to motor-boating. The reasons for this trouble are not yet all known, but it can be cured by using a large by-pass capacity across the A.V.C. output. Unfortunately, however, this increases the time constant to such a degree that the operation is not always pleasant, for the sensitivity of the set does not decrease quickly enough on tuning-in a strong signal, and rises only slowly as the set is tuned away from it, so that adjacent weak stations may be missed.

I.F. Valve Output

Now, it will be obvious that the only method of control which meets all requirements as regards simplicity, a low time constant, and the absence of any voltage negative with respect to the earth line, is the delayed diode system, and that the only disadvantage of the arrangement is that on a strong signal it requires such a large input that the last H.F. or I.F. valve is overloaded. Such overloading, of course, leads to serious distortion. The amplification of the diode output by a D.C. amplifier is not wholly satisfactory, is often inconvenient, and usually impracticable in a battery-operated receiver. Obviously, however, some form of amplification is needed. The solution would seem to lie in the provision of an extra stage of amplification preceding the diode A.V.C. system—a stage of amplification used only for feeding the diode, and not for feeding the detector.

It might be thought that this would confer no benefit and that overloading in the stage feeding the diode would still be prevalent. This is not necessarily the case, however, for this amplifier would not be controlled for A.V.C. purposes. A comparison of Figs. 1a and 1b will make this clear. The former shows the usual arrangement for delayed diode A.V.C., and it will be seen that the A.V.C. diode is fed from the last I.F. valve, and that the bias is applied to this valve as well as to the early stages. In the case of Fig. 1b, however, an extra I.F. valve is used only for feeding the A.C.V. diode and this is not controlled, for the bias is applied only to the same valves as before.

Now, in the case of variable-mu valves the output obtainable depends very largely upon the bias voltage applied, and it falls rapidly when the bias exceeds a certain figure. Thus, an output of 100 volts R.M.S. may be obtainable when the bias is −2 volts, but the limit may be reached at 5 volts with a bias of −32 volts. Such a bias may easily be needed for local reception, so some idea of the limitations of the arrangement will be apparent.

This will perhaps be clearer if a rough example of the actual voltages involved is given. Suppose that we are working with a delay of 10 volts. A signal of strength just sufficient to give a detector input of 10 volts peak will produce no A.V.C. bias. A band-pass filter is used as a coupling from the I.F. stage in most superheterodynes, but the carrier output of the I.F. valve will not be more

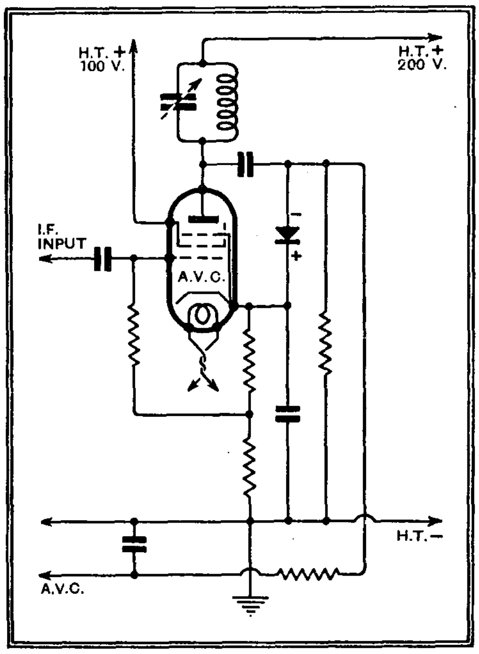


Fig. 2.—The connections for I.F. amplified A.V.C. using a screened H F. pentode and a Westector.

than ten volts peak; on eighty per cent. modulation this will rise to eighteen volts peak. It will be seen, therefore, that even on a weak signal the I.F. valve must give quite a large output. Now let us take the case of a stronger signal such that the detector input has risen to twenty volts peak (an increase of six db) so that the A.V.C. bias is roughly ten volts. The I.F. valve output on deep modulation must now be thirty-six volts peak, but the maximum undistorted output of even an H.F. pentode is unlikely to exceed about thirty volts peak at a bias of ten volts.

The difficulty could be largely got over, of course, by controlling only the early valves from the A.V.C. system. This is by no means a wholly satisfactory remedy, however. In the first place, the efficiency of A.V.C. is reduced, so that a larger bias is required on the stronger signals, which in turn means a larger detector input and a greater I.F. valve output. Secondly, the first valve of the receiver may have to handle a large input when the set is tuned to a local station, and the different operating conditions may not suit this stage so well.

Now, there is a big gain if we use a separate uncontrolled I.F. stage for feeding the A.V.C. diode, for since the output of this valve does not feed the detector proper any distortion which may occur in this stage is relatively unimportant, and does not affect the output of the receiver. It is permissible, therefore, to permit some degree of overloading in this amplifier. An H.F. pentode at about −2 volts bias will give an output of over 100 volts R.M.S. without distortion, or, say, 150 volts peak. It would be possible, therefore, to work with a delay voltage of seventy-five volts in the diode system, and to obtain up to seventy-five volts A.V.C. bias before overloading occurred on a carrier. Even allowing for 100 per cent. modulation, 37.5 volts bias could be obtained before distortion set in, and this would be ample to hold down the strongest local station with the usual three controlled stages.

There are many ways in which the system could be arranged, and one obvious method is to use an H.F. pentode to feed a separate diode, which might be a Westector, as in Fig. 2. Such a system would provide practically perfect A.V.C. and would have the great advantage, particularly for a battery receiver, of not increasing the total H.T. voltage required. The various elements could, of course, be combined in a single valve, and an H.F. pentode-diode would permit the abolition of the separate diode. No suitable valve is at present available in this country, however, for it would be necessary to use a valve with the control grid brought out to the top of the bulb, and the present diode-pentodes have the anode in this position.

A little thought, however, will show that an arrangement such as this is unnecessarily good. An A.V.C. bias of more than some thirty volts is rarely required, which means that the amplifier output need not exceed some sixty volts. A stage gain of 200 times would easily be obtainable with a good mains-type H.F. pentode, so that the input would be only 0.3 volts peak for the strongest signal. It is not usual to work the detector at such a low input on account of the distortion which might occur. We can, therefore, considerably reduce the amplification without adversely affecting A.V.C.

(*To be concluded.*)

THE RADIO INDUSTRY

THE Automatic Coil Winder and Electrical Equipment Co., Ltd., of Winder House, Douglas Street, London, S.W.1, announce an interesting competition, with valuable prizes, for users of the Avo Minor testing instrument. Among other things, competitors are asked to enumerate tests that may be carried out with the instrument, and some useful hints on this important subject should materialise.

An important announcement from Standard Telephones and Cables, Ltd., refers to the introduction of a complete range of universal A.C.-D.C. valves, comprising a variable-mu H.F. pentode, heptode frequency changer, double diode triode, output pentode, and full-wave rectifier. All valves consume 0.2 amp. at either 13 or 40 volts.

The address of Fluxite, Ltd. (makers of the well-known soldering flux) has been changed to Dragon Works, Bermondsey Street, London, S.E.1. Telephone: Hop. 2632.

An organisation to be known as T.M.C.-Harwell Sales, Ltd., is to be formed, and will take over the selling business of Harwell, Ltd., and the Telephone Manufacturing Co., Ltd. (T.M.C.), including the distribution of T.M.C.-Hydra condensers.