

Radio Frequency, Amplification and Selectivity

A Few Points on the Subject

By Megohm



RADIO amplification is obtained from two factors, the step-up in the valve, and the step-up in the r.f. transformer.

In some circuits there may be no step-up in the transformer, which will in such a case have a ratio of only 1 to 1, so that the total amplification of a stage will then be only that of the valve, and this is the case in the tuned plate type of circuit.

The theoretical amplification factor of the valve must not be taken too literally as an indication of the amount of amplification it will give in a practical circuit, as in actual use the amount is usually considerably below the theoretical value, and depends to a great extent upon the circuit used, more particularly that portion directly connected to the plate of the valve.

WHEN signal voltage is applied across the grid and filament of a valve, variations are caused in the plate current, that is, in the B battery current. There are two impedances in the plate circuit, the impedance of the valve and the impedance of the external plate circuit. The fluctuating plate current develops voltages across the external impedance, and these voltages are transferred to the grid of the next valve either through a coupling condenser, which is the method adopted in the tuned plate circuit, or through a r.f. transformer coupling, which latter method should give some step-up. In an efficient Browning-Drake receiver this step-up may be as high as 20 to 1—so an American authority has stated.

To obtain the full theoretical amplification of the valve, the external impedance must be very high, and the voltage is then all developed across it, and very little in the valve itself, but attainment of this ideal is practically

impossible, as there are other factors working against such perfection, so that the usual compromise has to be made, just as in many other parts of a radio circuit. This compromise is rendered necessary on account of the damping effect which is introduced into the circuit by the valve itself. If a resistance is shunted across a tuned circuit, it has the effect of making the tuning unselective and this is what the presence of the valve tends to cause, for it is the equivalent of a shunted resistance across the circuit. If the external impedance is high, amplification is high but selectivity is poor, so that a separate means of obtaining selectivity is necessary, or else a compromise must be made between amplification and selectivity that in the case of the tuned plate circuit, does not give the most desirable result.

A SOLUTION of this difficulty lies in the adoption of the r.f. transformer with primary and secondary windings, whereby it is possible to sacrifice a certain amount of amplification from the valve by decreasing the external impedance of the circuit, thereby gaining selectivity, and then more than make up for this sacrifice by the step-up in amplification gained from the transformer, at the same time reducing the damping effect of the valve by, in some cases, tapping it across a portion of the circuit only, whereby the coupling effect is propor-

tionately reduced. The best condition when the damping introduced by the valve is equal to that of the external circuit, and by adjusting the position of tapping this condition can to some extent be adjusted.

Effect of Resistance.

ONE of the effects of resistance in r.f. circuits is usually to flatten the tuning. This is surprisingly shown if measurements are taken of the current passing through the circuit at resonance point (that is, when tuned for the best reception of a given wave) and at points a little off the tuning point. In one case where the tuning was on 350 metres, with little resistance in the circuit, an alteration of the tuning 2 metres above or below the 350 reduced the current in the circuit to one-half its best value; this shows how sharp was the tuning in the low-resistance r.f. circuit.

In a higher resistance r.f. circuit, however, tuned for 350 metres, the best current was only about one-half the best value in the above case, and furthermore it required a de-tuning of 30 metres on either side of the 350 to reduce the current in the circuit to one-half of its own best value. Thus the tuning was "flatter," and this illustrates why, with a flat-tuned circuit, wave-lengths near the desired wave-length come in with very nearly the same intensity, whilst with a sharply tuned circuit, if another wave-length is the least amount off the desired value, its intensity of reception is reduced to a small fraction of that of the desired wave-length.

Aperiodic and Tuned Transformers.

SOME types of radio-frequency transformers employ "aperiodic" coupling, which does away with the necessity for tuning each stage, but one great advantage of employing tuned circuits is that selectivity is thereby increased, and the wanted signals therefore amplified to a much greater extent than the unwanted ones, or atmospheric disturbances. Some modern types of r.f. amplifier, employing three stages, can give an amplification of 1000 or more at certain definite wavelengths, and of 400 to 800 at any wavelength over a certain range. But it must be remembered that the factors in favour of amplification are to a great extent against selectivity.

Laboratory measurements of two three-stage transformer-coupled r.f. amplifiers supposed to be identical, and manufactured from the same specifications, have shown one to give less than one-third the amplification given by the other, which goes to show that not everything is yet known about this class of amplification.

THE wave-length of a broadcasting is subject to "side band" fluctuations, between the limits of audio-frequency, on either side of the carrier.

Thus, the carrier wave of a 300-metre station has a frequency of 1,000,000 cycles per second. Speech may cause variable side frequencies between about 990,000 and 1,010,000 cycles. To receive broadcast transmission the resonance curve must be sufficiently flat to cover the band 10,000 cycles either side of the carrier without noticeable distortion. This is the reason why a highly selective receiver may cause distortion or light-note loss by cutting off or unduly weakening amplification of the sidebands.

Using Reaction.

WHEN we work up a weak and distant signal by applying a good deal of reaction we may, without always realising it, render the set so selective by making good the damping losses that a certain amount of cutting of the outer sidebands takes place, with considerable detriment to the quality: too little in such circumstances is heard of the treble; speech sounds rumbling and music is drummy.

You will always get the best quality, particularly from the loudspeaker, when the set is working well within itself, that is, when signal strength could be made greater if it were desired to do so.

The resistance of a wire to r.f. currents increases with the frequency, so that other things remaining equal, the aerial circuit resistance, and therefore the need for reaction, is greater on the short waves. The band of frequency variation due to modulation remains the same (10,000 cycles either side), and so the proportion of this to the whole frequency (which is much increased on short waves) is less, so that we can work nearer to oscillation point and obtain better amplification by reaction without serious distortion. Reaction is therefore more necessary, more effective, and less distorting on short waves.

Stability.

NOTHING has yet been said regarding stability, which is indispensable in any r.f. circuit, and in order to ensure it, considerable amplification has often to be sacrificed.

The Double-Roll Speaker.

THIS speaker, built to the dimensions given, is the equivalent of a 26-inch cone. The paper used for the diaphragm should be rather heavier than that used for the cover of the Government telephone directory, which forms a handy standard of comparison. The omniphone unit for this speaker is also stocked by the Rodger Importing Company, 159 Manchester Street, Christchurch, at 30s.

Field Current for Coil-Driven Speakers.

A PARAGRAPH in "Radio Broadcast" states that for the excitation of coil-driven speaker magnets requiring six volts, this can be adequately supplied by many of the popular trickle chargers with a Tube A block connected across its output to eliminate hum. This combination, it is stated, is altogether satisfactory, not a trace of a.c. hum being perceptible in the speaker, which functions at full efficiency, referring specially to the Jensen and Magnavox types.

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