The Finer Points of Radio

The Biasing of Amplifying Valves

By "PENTODE"

EVERY three-electrode valve, when working in the capacity of an amplifier, requires a negative potential applied to the grid. If negative bias is not present, grid currents flow, the valve rectifies, and is of no use as an amplifier.

But some readers will say, "Ah! I have you. My set has no C battery, yet it works." Well, try the effect of absolutely no bias by connecting a potentiometer across the filament leads and taking the grid return to the centre arm.

On receivers and amplifiers using no separate grid bias battery a slight negative potenial is automatically produced when the grid return of the valve is connected to the minus filament lead and the valve of this bias can be taken as approximately half the A battery voltage.

Correct biasing is essential in all receivers and the amount depends upon the valve and conditions under which it works, and before passing to various methods of obtaining bias let us consider the various valves in, say, a five-valve set, and see if we cannot determine the correct bias on each valve theoretically.

Voltage Amplification.

THE voltage built up across the first grid coil amounts to one or two millevolts, and bias on an R.F. valve need only be sufficient to give economical running on the B battery. When delivered to the detector valve this will be built up to a pressure of .01 to .075 volts, and it can be taken that the average grid leak and condenser detector valve has an output of from .1 to .75 volts, and this is delivered to the first audio frequency transformer.

Until this time none of the valves have been overloaded, and even if a bias of a mere 0.5 volts was applied to each of the R.F. valves, this would be sufficient. Following from the detector valve let us calculate the voltage applied to the grids of the suceeding valves. First of all comes the transformer following the detector valve, having a voltage amplification factor of 3.5.

An average detector output of .5 volts gives a swing of .5 x 3.5 equals 1.75 volts applied to the grid of the first audio valve. This consists of a swing of .875 volts on either side of the working point of the valve and 1 volt bias only would be adequate to prevent distortion.

Continuing, a general purpose valve having an amplification factor of 8 produces swing of 8 x 1.75 equals 14 volts in the anode of the first stage valve valve. A further transformer having a 1 to 3.5 ratio impresses a swing of 49 volts on the grid of the final valve. Now, this surely suggests at least a power valve in the position, and after reading this the reader will render a few sympathies to the poor 201 A type of valve expected to work under these conditions.

To make matters worse there are still sets in use that not only use a general purpose valve in the last stage, but also use no grid potential. A grid swing of 49 volts can be handled only by a valve using negative potential at least equal to 25 volts.

Concerning a Power Valve.

FROM this simple calculation, one or two important points are outstanding. The first is that even a semi-power valve is not necessary on the average receiver in the second to last stage. Why use a valve capable of handling a grid swing of 18 or so volts when in actual use only 1.75 to 2 volts are applied when the last valve is on the point of overloading.

The second point to notice is that the average listener blames everything from his aerial to his speaker when he uses only a 4½ v.c. battery and an unsuitable final stage valve. By referring to valve characteristics it will be found that a valve capable of handling this input requires a high tension voltage of anything from 180 to 400, and some readers will be up in arms against this. Push-pull amplification solves this problem, and where low plate voltages are to be used this method is strongly advised. When we say that a high-frequency valve is overloaded we do not think of the voltages that would be built up at each stage if this was the case. If a high-frequency valve was actually overloaded in this way and the detector would take the input, a valve-using grid bias of several thousands of volts would be required after three or four stages had done their work.

"Grid Resistance."

SPEAKING of receivers having no provision for a C battery, there are several that do overcome this necessity by using a so-called "grid resistance." In effect, this actually takes a little off the tail-end of the B supply, making the filament positive with regard to the grid, which is at earth potential. To explain this more fully, grid bias can either be obtained by making the grid more negative with regard to the filament, or making the filament more positive with regard to the grid. Usually the filament is at zero potential, the grid is negative, and the plate positive. Now, making the grid at zero, the same result can be obtained by making the filament slightly positive.

Although this could be done in the case of a single valve by taking the filament tapping part of the way up the B battery it is usually accomplished by using the voltage drop across a resistance. Assume a resistance of 5000 ohms to be connected across a 100-volt battery. Appoint a negative and positive end of the resistance and take a tapping of 1000 ohms from the negative end. Of these three tappings connect the negative end to the grid return, the centre tapping to the filament and the positive tapping to the plate, and consider the state of affairs. First the grid would be negative regarding the filament to the amount of one-fifth of 100 volts, and a grid bias of 20 volts would be applied. But the plate would be only 80 volts positive with regard to the filament, because the voltage drop across 5000 minus 1000 ohms equals 4000 ohms, would amount to only 80 volts. So that when the grid bias is taken from the voltage drop across a resistance it robs a portion of the B supply.

Employing Valve Impedance.

A VALVE has a resistance of its own, why not substitute the resistance of the valve for that portion of the resistance between the filament and plate in the example cited above? This is what is actually done in many sets, and most of the commercial power amplifiers. To set about determining the value of this resistance all we need to know is the normal anode current taken by the valve at different B and C voltages, and also the available B supply. Consider the case of a power-valve passing 20 milliamperes at a B voltage of 150, employing 25 volts negative bias. A high-tension voltage of 175 volts would be required, and we would have to calculate what value of resistance through which a current of 20 milliamperes is passing would give a voltage drop of 25 volts.

According to Ohm's law, 1 volt is dropped across 1 ohm carrying a current of 1 ampere; and 25 volts are dropped across 25 ohms resistance, carrying 1 ampere, or 1000 milliamperes; therefore 25 volts are dropped across 1250 ohms resistance, carrying 20 mas.

In the case of a final stage valve of the above specifications and operated from a separate winding on an AC transformer, a resistance of 1250 ohms connected between B and the centre tap on filament transformer, and the grid return to B—, would provide a grid potential of 25 volts and an anode pressure of 150 volts. For obvious reasons the above is only of use when the last valve is operated from a separate A battery or filament transformer winding and in practice the resistance is always shunted by a 1 or 2 m.f.d. condenser.

Technical Briefs

TESTING a dry cell by the glow from a flash-lamp battery is rather hard on the cell, as the average bulb requires far more current to light it than is normally drawn from the cell.

THE necessary current to energise the mains-driven type of moving-coil loudspeaker can practically always be taken direct from D.C. mains, as it does not have to be filtered or smoothed like that of H.T. mains units.

IF an accumulator is stood aside for a time it should be given a really good charge every eight weeks or so to keep it in good condition.

DO not lose the little plugs on the top of the accumulator, as these play an important part in its correct operation.