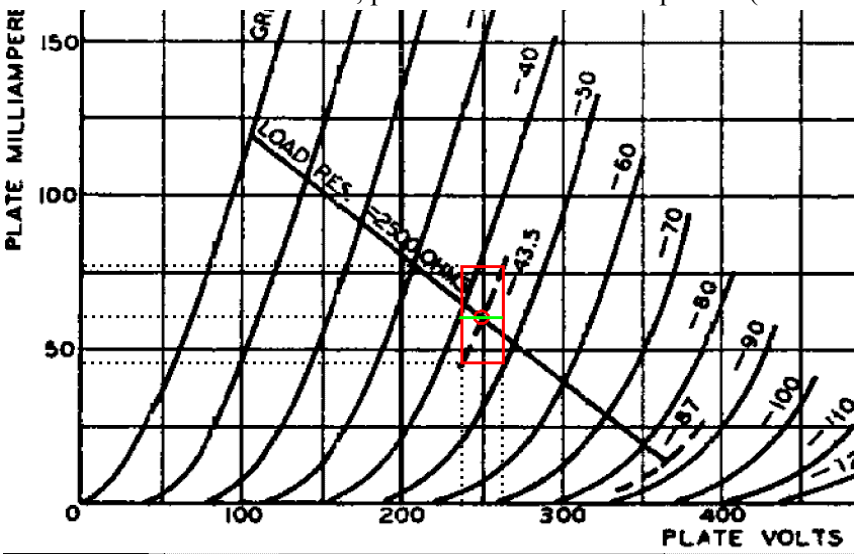
Auto fixed bias (AFB)

Power tubes need to be biased. For power tubes there are coursly two ways of biasing, auto bias and fixed bias.

1) Auto bias is done by a resistor in the cathode line. Advantage is that the tube auto biases itself, more voltage means more current and thus more bias voltage, keeping the current down. Disadvantage is that you have a large resistor in the signal, which for best sound must be bypassed with a capacitor, which also is in the signal. Also mostly a lot of heat dissipation will occur and you need more B+.
2) Fixed bias is achieved by applying a negative voltage to the grid, and connecting the cathode to the ground. This way means a more simple line of signal. Fixed bias is know for its better sound, especially when low values of grid resistor are used, or even better, grid chokes.

The big problem with fixed bias is that the tube does not find it's own bias point. When for example the B+ anode voltage changes somehow, or if the tube gets older, is changed or the coupling capacitor gets a small leak (and all types capacitors will develop this in time), the anode current will also change. This can result in bad biasing and tube damage or degrading sound. To handle this you always see bias adjustment and meters on fixed bias tube amplifiers.

A good example of changing current is the changing of the socket mains voltage. This voltage typically changes about +/- 5% over the day. When the bias voltage is regulated (which most of the times is the case) and the B+ changes, the anode current also changes. This is a disturbing large effect. I have put an example for a 2A3 biased at 250V/60mA/-43.5, please take a look at the picture (red square). If the mains voltage changes +/- 5%, the B+ voltage also will change +/- 5%. When the voltage in this case goes from 238 to 263V, with a fixed bias voltage of -43.5V , the current changes from 45 mA to 78 mA. In this particular case this means a dissipation sweep of 10.7W to 20.3W, that's 100% change! The maximum disspation of the 2A3 is 15W, so there is a chance the tube is part of the time way above its maximum rating, reducing tube live a lot.



In many datasheets you see that a lower bias current is recommended for fixed bias. For example the maximum current for auto bias or manually operated fixed bias of a JJ Electronics 300B is 100mA, where it is maximum is 70 mA for fixed bias. This has to do with the above effect. The large change in dissipation also means the tube never gets really stable in temperature, it looks like the amp is continuously breaking in, never getting to it's optimal point. Especially mid-range like voices and bass will never get really precise as is can be.
To solve this problem and all the hassle there always is with biasing the tubes, we have designed the Auto Fixed Bias circuit (AFB). This circuit adjusts the negative grid voltage so that the anode current always is exactly the value you want it to be. The circuit only works for frequencies well below audio range (DC), it is fast enough to follow the mains changing output and tubes wearing. But it is very slow compared to audio signals. This way it conceals itself for music, but keeps the tube at exact the

point you want it to be. In the 2A3 curves it means the tube bias point changes over the green line. In this case it changes from 14.3W to 15.8W. This is much less changing than normal fixed bias and thus much more stable biasing. The sound will get better, and the tubes will live longer.

The AFB is very good for SE circuits, but maybe even better for PP circuits. Since it exactly tunes ALL the tubes at the current you want, all the time, the balance also will be exactly 100%. This means Push-Pull amplifiers will work at optimum power with minimum distortion. Also when tubes are changed, the amplifier will adjust itself to the most optimal operating point.

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