Constant current source (CCS) tube loading

In our experience a tube sounds best when:

1) It is solidly biased at dc. A good constant biasing takes care the tube stays at the same temperature. When it is not biased properly, it will change a bit all the time and never will go in steady state and keep a bit fuzzy and unclear (like an amplifier that is not warm yet). Especially class A amplifiers suffer from this problem.
2) It has a very high load at ac (music signal). When looking at the small signal replacement scheme of a tube, all distortion factors reduce to nearly zero when the current swing is low. It has to do a lot with the gm changing with current, resulting in changing of the plate impedance and thus production of harmonics.

So we have to take care the tube has very solid bias en is loaded with a very high ac load. High load means that there is a lot of voltage swing, but almost no current swing (ie Ia=Va/Rload). This results in very lineair undistorted sound. It is very logical to use a constant current source, since they have exactly these features.

The combination of tubes and transistors in one stage is used very rarely, while they make really good amps when used properly. Each part must be used where it is best. A tube is a very good voltage amplifier, a transistor makes a very good current source. Combining these two really gives improvements against conventional circuitry. Measuring with spectrum analyser shows very little harmonics. A square wave keeps very square over the whole audio range.

Another advantage comes form the high impedance of the CCS. All noise from the power supply (Hum and Hf, the CCS has very high bandwidth) will drop over the CCS and not over the tube. It will not get into the amplifier, the CCS typically damps power supply noise by -50dB, depending on the tubes used. Driver stages and pre amplifiers have greater stage and will be much more quite and easy sounding.

When using CCS in a driver stage, it is very important to choose the right tubes. A lot of amplification is needed, but also driving current (driving the input capacitance of the power tube) and low output impedance. We do not use standard tubes like the ECC81, ECC82, ECC83, E88CC, 6SL7, Ba, 6SN7, WE310A, etc. Mostly they have low gm, meaning low driving power and high output impedance. Also most of the time they are not really lineair. There are a lot of tubes much more capable for audio purposes, for example combining high amplification, high current and low output impedance. Examples are 5842 or WE437A, EC8010 or EC8020, but also much cheaper tubes like EC91, E180F, D3a, E810F in triode, EC86, PC900, 6C45pi, etc. All these tubes are very lineair and are great drivers and can be used directly with only one stage CCS loaded into the power tube.

The CCS circuit also can be used very well in the tail of long tailed pair phase splitters (current sink). Normally there is a resistor there, but the signal error is equivalent to the cathode impedance devided by this resistor. Mostly this is compensated by a variable resistor in the anode of one of the tubes. When the impedance in the tail is very high (ie CCS) this error reduces to zero and you will get a very good phase splitter, making the sound better, without a variable resistor which need to be tuned all the time. Even when the tube is not matched internally.

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