Subject: 300B Project, Part 6 - Cascode driver a little more
Posted by Damir on Sun, 19 Feb 2006 16:55:43 GMT
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Last time (Part 5) we examined modified cascode – V2 works with 10mA of anode current, and V1 gets additional 10mA "through" R5, total 20mA.I replaced Rg=220k/Ci=0,22µ combination on the 300B grid with grid choke, modeled here as L1=1700H with Rw=8k in a series and paralelled with Cw, unknown capacitance; and enlarged Ci=4µ7 (to decrease Q of the circuit, to avoid subsonic resonance).Later I referenced R4/C1 to the cathode of V1 instead of ground – little change in operation point(s), little more amplification, but (subjectively) maybe a little less clean sound - I`m not sure. With this circuit I measured (larger) A=45 times with 5687 tube, and A=53 times with E182CC, driver has a very large grid choke impedance as a load.E182CC gives little more "clarity" and "bright" sound, and 5687 was "warm", more natural on vocals, but also a little more "mushy" (distorted?).The bass was a little "anemic", and highest frequencies little rolled off – this gives "bright and warm" combination at the same time… Unfortunately, I don`t have measuring devices to confirm my subjective opinions… Another change was installing the CCS parallel with Ra, the current through Ra is about 10mA, and CCS gave another 10mA. Then we have 20mA through both tubes. I used anode output (showed on the schematic), and low impedance Mu-out on the cascoded DN2540N5 CCS ("Guinevere" style). Both output sounded similar, bass «punch» returned, and sound was more "balanced". Anode out (high impedance) gave little warmer and softer sound. Amplification also incriesed a bit, A=48 for 5687, and A=55 for E182CC. The sound characteristics of 5687 (warmer, darker) and E182CC (brighter) retained in this circuit also.And this is the "classic" cascode, with Ra=12k load resistor, Ia~13,7mA with E182CC and little bit more with 5687 tube.E182CC gave "sufficient" A=32 times (measured) , but 5687 is "on the edge" with about A=28,5 times.The sound is warm, and a little "thick" and bright at the same time (?) The complete calculation:V1=E182CC : 116-3,7=112,3V/13,7mA/-3,4VFrom the anode curves: µ~23, rp1~2,4kOhm, S1=9,58mA/VWe have a unbypassed Rk, and our real rp1`~rp1+(µ+1)Rk = 8,4kOhms, S1`=µ/rp1` = 2,738mA/V – where Rk=Uk/Ik = 3,4/0,0137~250 OhmsWe neglected here the effect of R4/C1 referenced to cathode of V1, `cos of simplicity.V2=E182CC: the voltage "across" Ra is Ura = Ia*Ra=164V, and Uv2=(440-164)-116 = 160V. From anode curves: rp2~2,7kOhms, S2~8,5mA/V, µ~23; and cos of unbypassed Rk we have rp2`~8,7kOhms and S2`~2,64mA/VFormula A = S1`*Ra = 2,738*12 = 32,86 times, more datailed formula (M. Jones book) givesA=29,8 times. Simulation with simple E182CC model gave A=33,7 times.I measured A=32 times, pretty in line with theory. There`s a large choke impedance for the external load, and effect on amplification (lowering) is negligible.Output resistance of the driver is internal cascode impedance in parallel with load resistor:Rout = Rin // Ra = ((µ+2)rp1`)//Ra = 210//12 ~ 11,35 kOhmsCONCLUSION: The cascode has many good characteristics – from very low input capacitance to good amplification (larger then µ of the actual tubes used). It needs rel. large supply voltage (two triodes in series + load resistor) and "elevated" heater supply (about 50V) - center tap of Uh=6,3V connected on voltage divider (100k/3W and 12k bypassed with 22µ/100V cap).But, my opinion is that relatively large output resistance of the cascode driver in combination with grid choke load gives subjectively a little too "warm and soft" sound (and "strident" too in E182CC case). Again, this is a subjective judgment, based on just a few E182CC (Philips and Amperex) and 5687WA (Raytheon) samples in short time listening tests…To be continued – (simple) common cathode triodes 300B driver coming soon…