

Eagle Type B Balanced Neutrodyne Receiver (5 tubes) 1924-1925

United States, 1924/1925
Eagle Radio Co. ; Newark, New Jersey
Brand : Eagle
Type B Balanced Neutrodyne

From Wikipedia:

"The Neutrodyne radio receiver, invented in 1922 by Louis Hazeltine, was a particular type of tuned radio frequency (TRF) receiver, in which the instability-causing inter-electrode capacitance of the triode RF tubes is cancelled out or "neutralized" to prevent parasitic oscillations which caused "squealing" or "howling" noises in the speakers of early radio sets. In most designs, a small extra winding on each of the RF amplifiers' tuned anode coils was used to generate a small antiphase signal, which could be adjusted by special variable trim capacitors to cancel out the stray signal coupled to the grid via plate-to-grid capacitance. The Neutrodyne circuit was popular in radio receivers until the 1930s, when it was superseded by the superheterodyne receiver".



I. Placement of tubes on the chassis:



Tubes:

1st, 2nd RF (201 A, 301 A); 3rd detector (200 A, 300A); AF tubes 4th (201 A, 301 A), 5th (201 A, 301A, **71A**)
Observation: Cunningham CX301 A tubes, special made for neutrodyne apparatus are recommended.

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II. Battery connections:

A- = B- = C+ = GND (switch ON);

A+ = 6.3 V, Det = + 22.5 V, B+ = + 90 V, C- = - 4.5 V

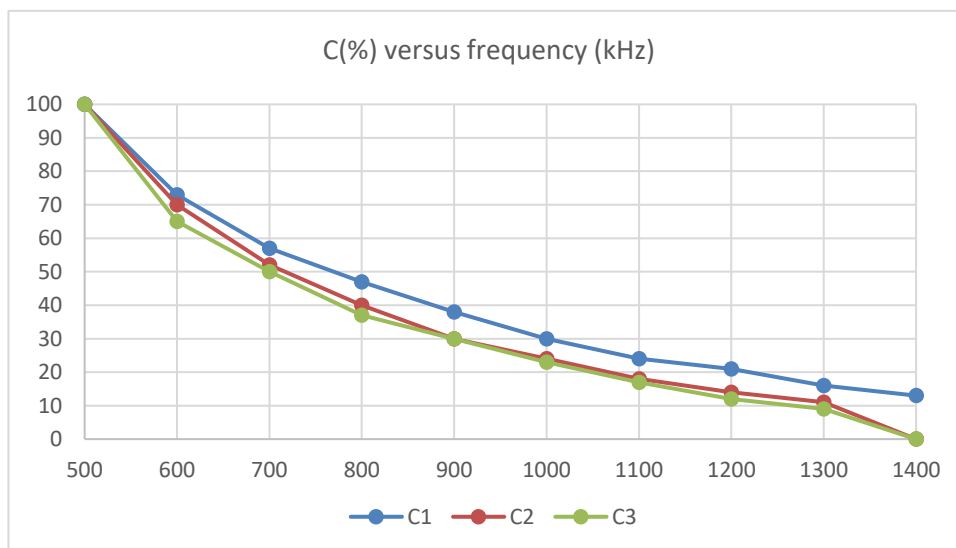
Stronger AF

A+ = 6.3 V, Det = + 22.5 V, **B+ = + 135 V, C- = - 9 V**

III. **Tuning:** variable capacitors from 0 % (minimum capacitance) to 100 % (maximum capacitance). Reception cover AM broadcast of 210 m (1410 kHz) to 600 m (500 kHz). First tune C2 and C3 according to the table. C1 is for antenna tuning, therefore function of the antenna impedance.

With a signal generator connected to “short antenna” input using a matching circuit for the 50 Ω output of the RF generator (small black box in the test bench picture, last page):

No	Frequency (kHz)	C1 (%)	C2 (%)	C3 (%)
1	500	100	100	100
2	600	73	70	65
3	700	57	52	50
4	800	47	40	37
5	900	38	30	30
6	1000	30	24	23
7	1100	24	18	17
8	1200	21	14	12
9	1300	16	11	9
10	1400	13	0	0

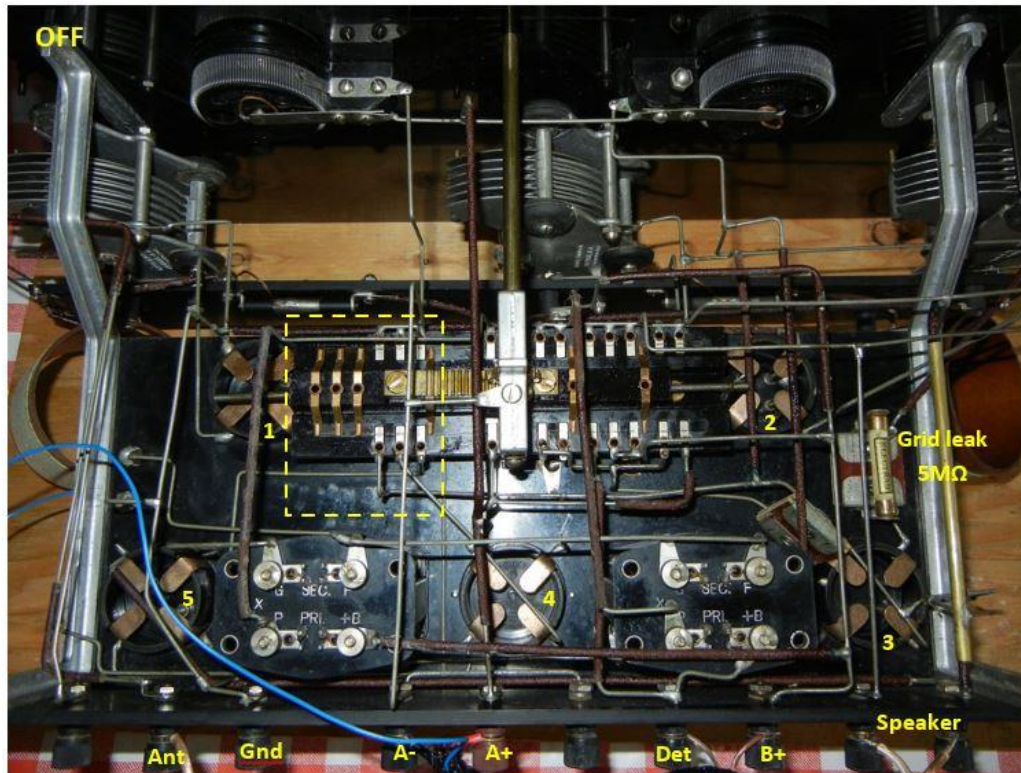


IV. Amplifier Switch Positions:

Only cathodes of required tubes for each switch position are connected to 6V DC. Positive voltage is passed by the rheostat to adjust cathode heating voltage from 0 to 6V DC, and therefore to control the gain (amplifier rheostat). The ground connection is ON or OFF for each tube function of switch position, to heat or not the tube. The yellow dotted rectangle highlights this power switch.

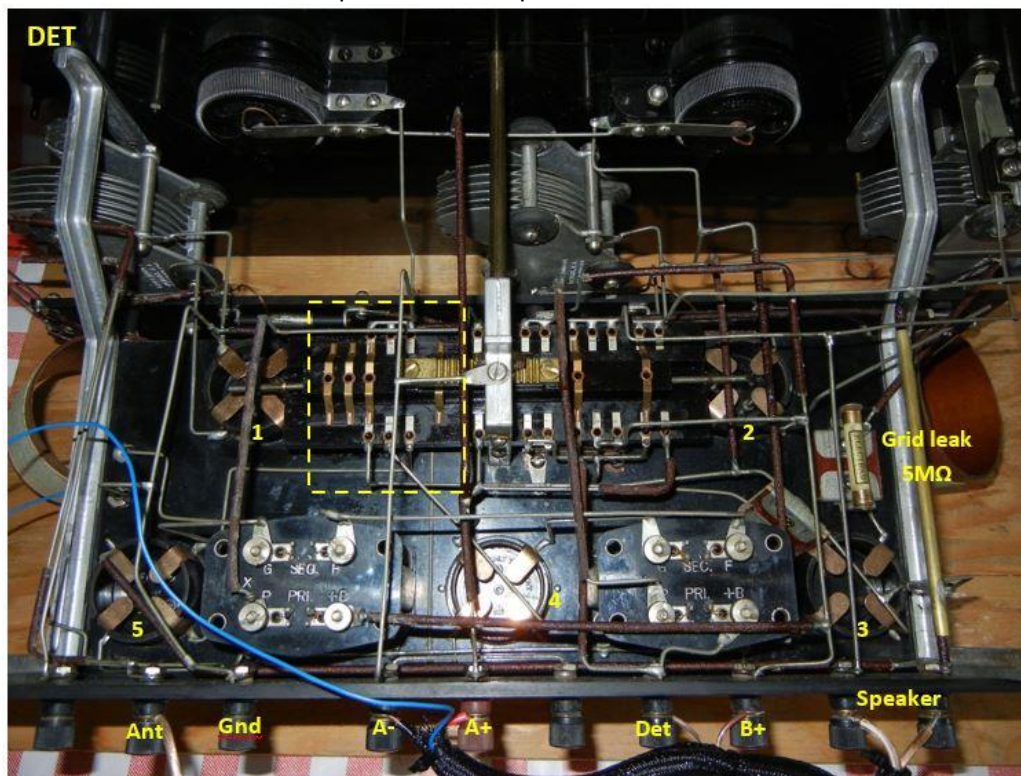
The Headphones are connected in parallel with the Speaker. Therefore, inserting the headphone will not disconnect the speaker. Other switches connect always the AF output at the correct tube output, and also B+ to the AF tubes that are working.

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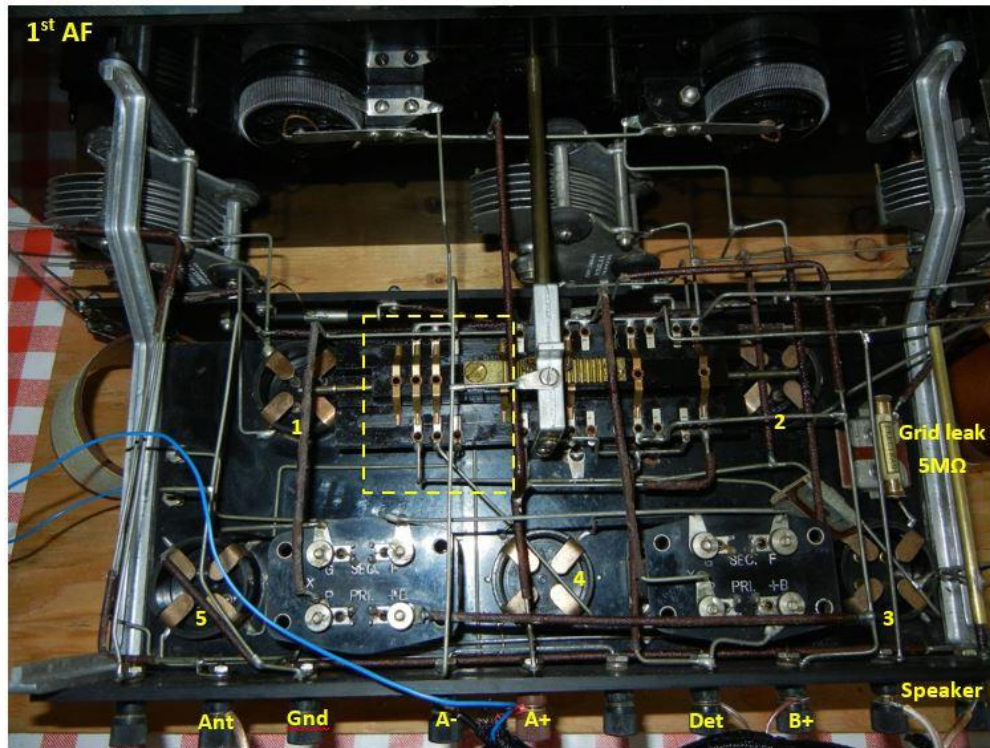
DET: tubes 1 to 3 are heated

The AF output can be listen in headphones, and weak on the speaker. AF output is connected directly to the to the detector tube output. The AF amplifier tubes 4 and 5 are OFF.

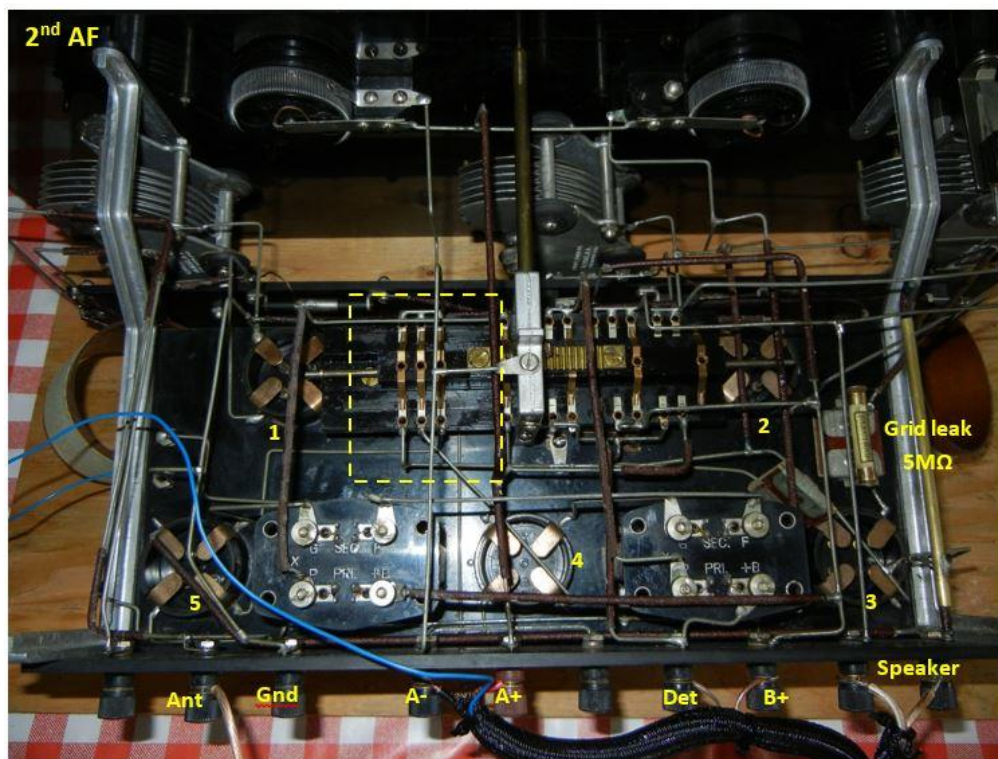


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1st AF: tubes 1 to 4 are heated

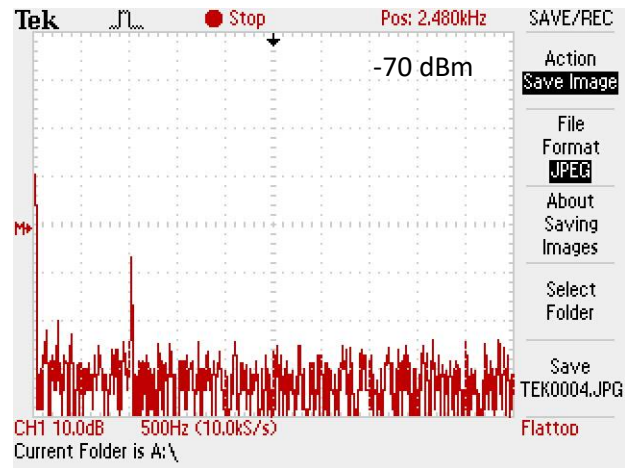
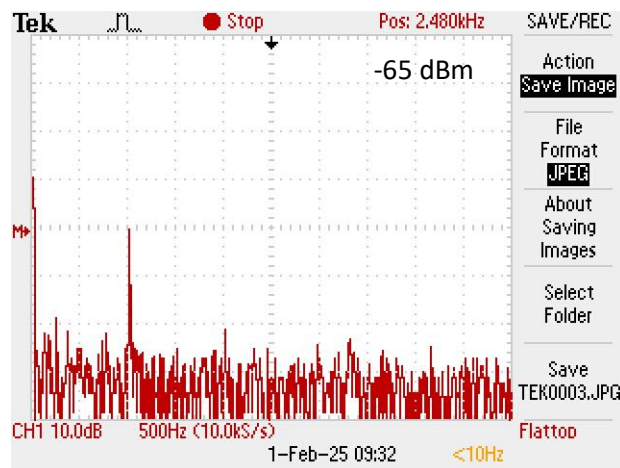


2nd AF: all tubes are heated

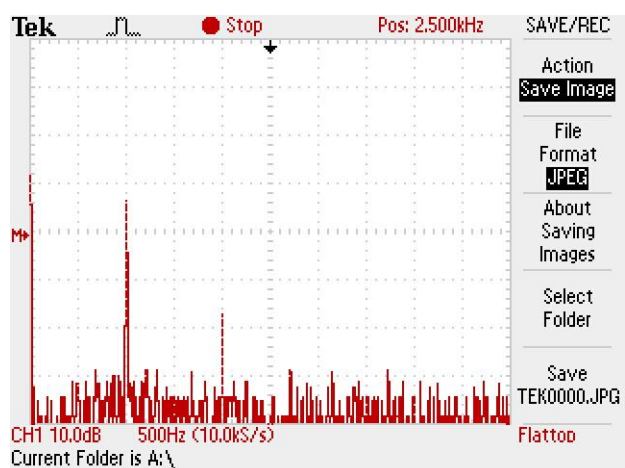
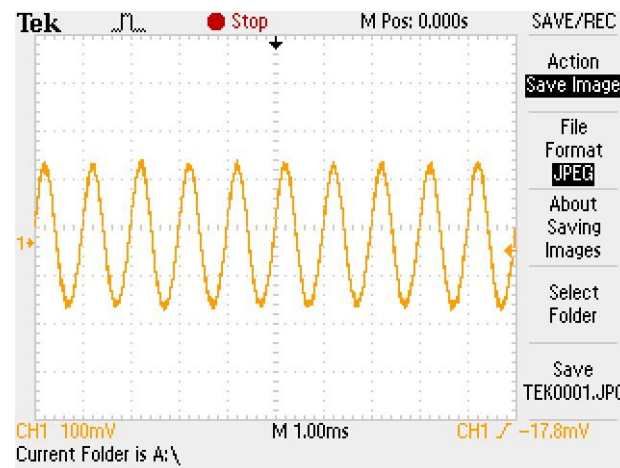


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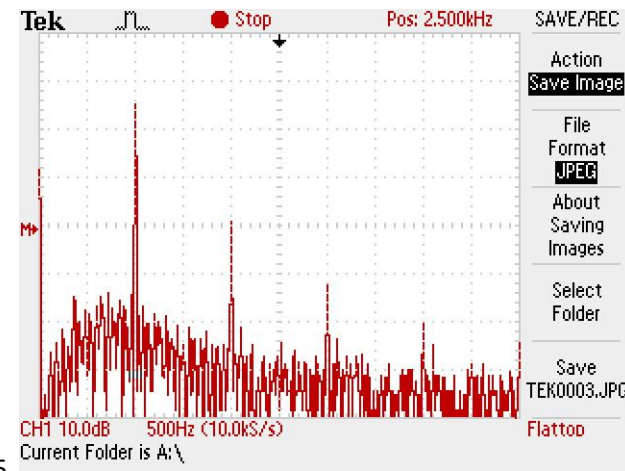
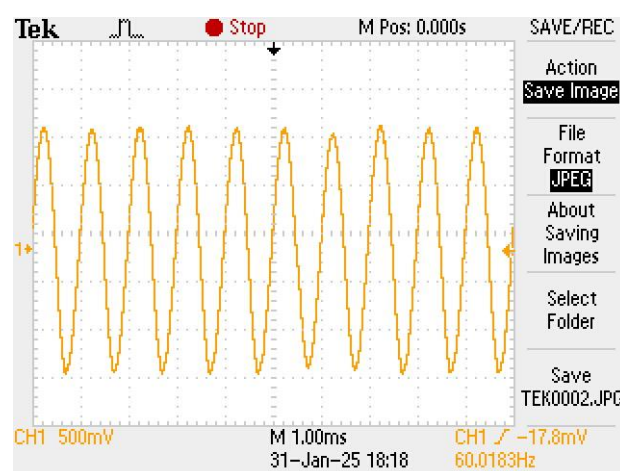
V. Receiver sensitivity is less than -73 dBm over the band (works better at higher frequencies) with a very good signal to noise ratio (measured with Rohde & Schwarz SM300 signal generator, **2nd amp ON**). Receiver sensitivity with only **1st AF ON** measured at 1 MHz carrier is around -65 dBm with a S/N ratio of around 20 dB. **Noise level** is less than -80 dBm, a little bigger at lower frequencies in AM band.



VI. AF demodulation test: 1 MHz RF, -50 dBm RF power, 75 % modulation index, 1 kHz audio, **1st AF ON**, **2nd AF OFF**. The **2nd harmonic** is around 25 dB below the 1 kHz tone. **3rd harmonic** is on the noise floor.

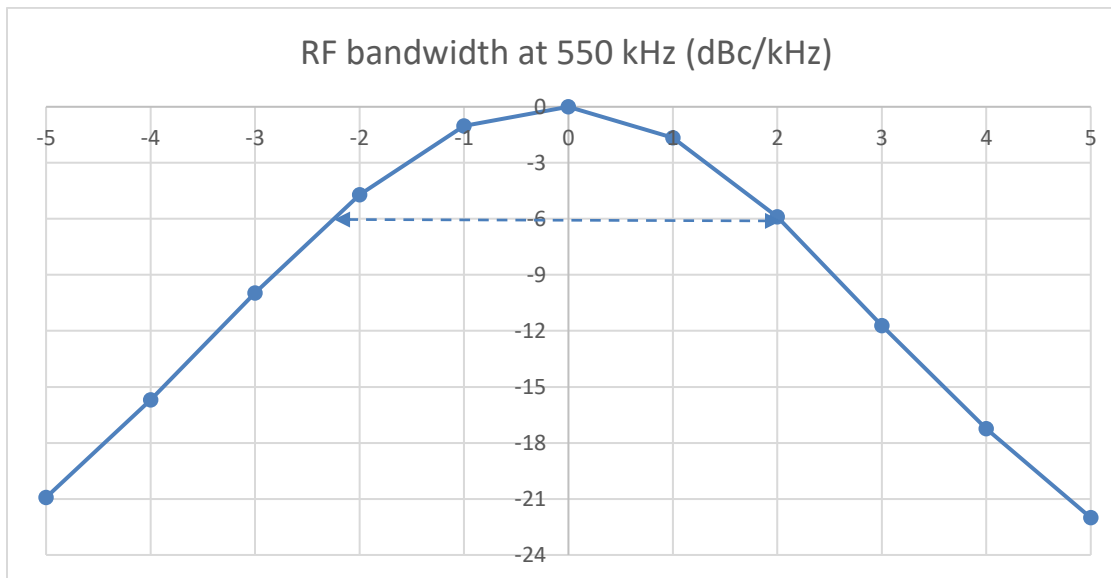
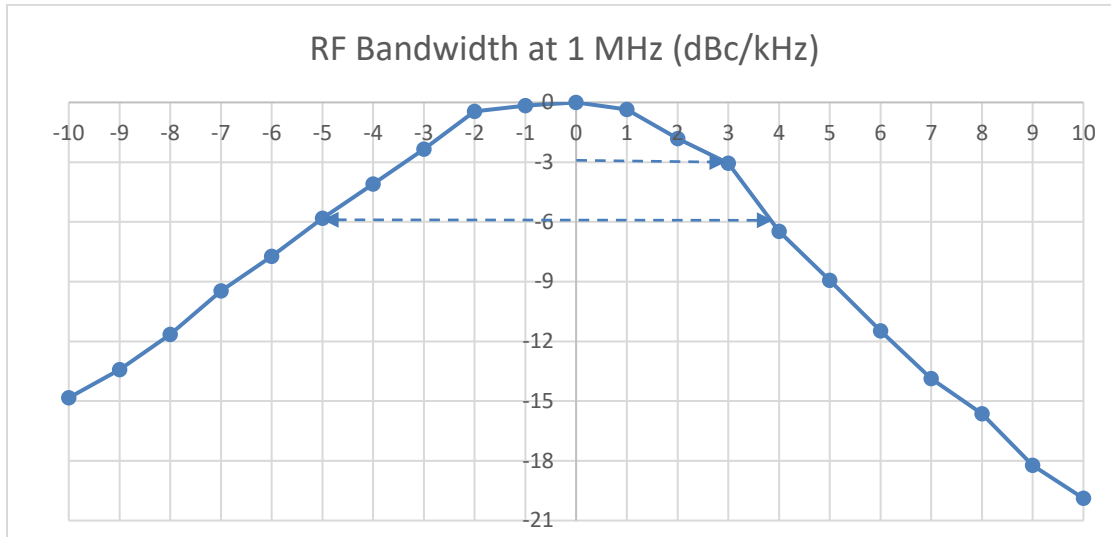


Higher gain from **Amplifiers rheostat** (+ 20 dB): **3rd and 4th harmonics** are visible



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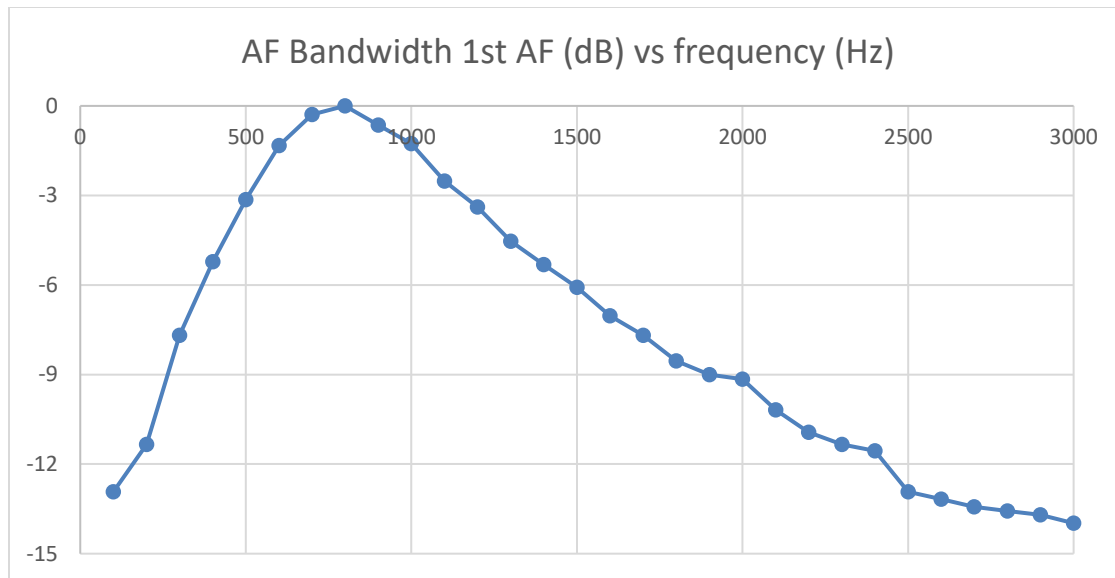
VII. Minimum RF bandwidth, corresponding to maximum gain, measured at 1 MHz and 550 kHz:



The output voltages are measured at the 1st AF output. The RF bandwidth can be increased to improve the music quality using the three knobs (slightly detuning the capacitors). As observed, the RF bandwidth is dramatically reduced at 550 KHz.

VIII. The AF bandwidth is measured also at the 1st AF output at 1 MHz. The RF bandwidth is included in measurements because the AF signal is obtained by demodulation without using a separate AF signal generator. At 1.5 kHz and 3 kHz the RF bandwidth attenuation is -1.5 dB and -3 dB respectively. This supplementary RF bandwidth attenuation can be easily de-embedded. The 6 dB AF bandwidth is relatively narrow just a bit wider than 1 KHz, good for voice and at the limit for music. However, for the horn speakers having a better response around 1.5 kHz, the audible frequency band looks wider.

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IX. Test bench: Rohde Schwarz SM300 Signal Generator, Tektronix TBS1104 Digital Storage Oscilloscope



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