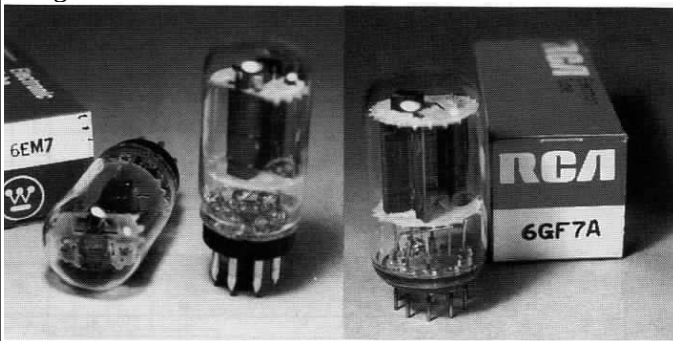


Vacuum tube resistor method 6GF7A/6EM7PP Amp construction



The vertical deflection oscillator auxiliary triple triode unit 2 was used as the output tube. Push-pull power amp This is the 4th report on the construction of a PP amp using 6GF7A & 6EM7.



Comparison between 6GF7A & 6EM7

Table 1 shows the max ratings & operation examples or static characteristics of 6GF7A & 6EM7

	name		6EM7	6GF7A
	Er, Ir	VxA	6.3 x 0.9	6.3 x 06
	Eb	Vdc	330	330
	epm	kVdc	1.5	1.5
	Pp	W	10	11
	ik	mAdc	50	50
	ikm	mAdc	-	175
#2	Eb	Vdc		150
	Ec1	Vdc	150	-20
	Ib	mAdc	-20	50
	gm	mOhm	50	7.5
	rP	kohm	7.2	0.75
	mu	-	0.75	5.4
#1	rp	kohm	40	40
	mu	-	64	64

Construction #1: Construction 1, #2: Construction 2
(Table 1) Main specifications of 6EM7 & 6GF7A

The figures shown are for the two tubes. The only difference is the maximum plate loss rating & gm, otherwise the values are the same. The sockets are different, so they cannot be replaced.

If the connection pins are the same, they are not similar tubes but equivalent tubes. Considering the name & shape of the tube, it seems that the 6GF7 & 6GF7A appeared when the GT tube 6EM7 was remodelled into a no-pal tube.

Checking the characteristics with the E_b - I_b curve
The Vacuum Tube Manual (both Radio Technology Co & RCA) lists the E_b - I_b curve for the 6EM7, but not for the 6GF7A. The RCA manual's 6GF7A entry states that the E_b - I_b curve for unit 2 follows that of the 6EM7. So I looked into the E_b - I_b curve for the 6EM7.

The E_b - I_b curve is listed, but

Resting plate voltage E_{b0}	150V
Resting plate current I_{b0}	66mA
min plate voltage E_{bmin}	51V
max plate current I_{bman}	78mA
max output $P_{O3.8W}$	3.8W
Average current at max signal i_p	43mA
Plate loss at max signal P_p	4.6W

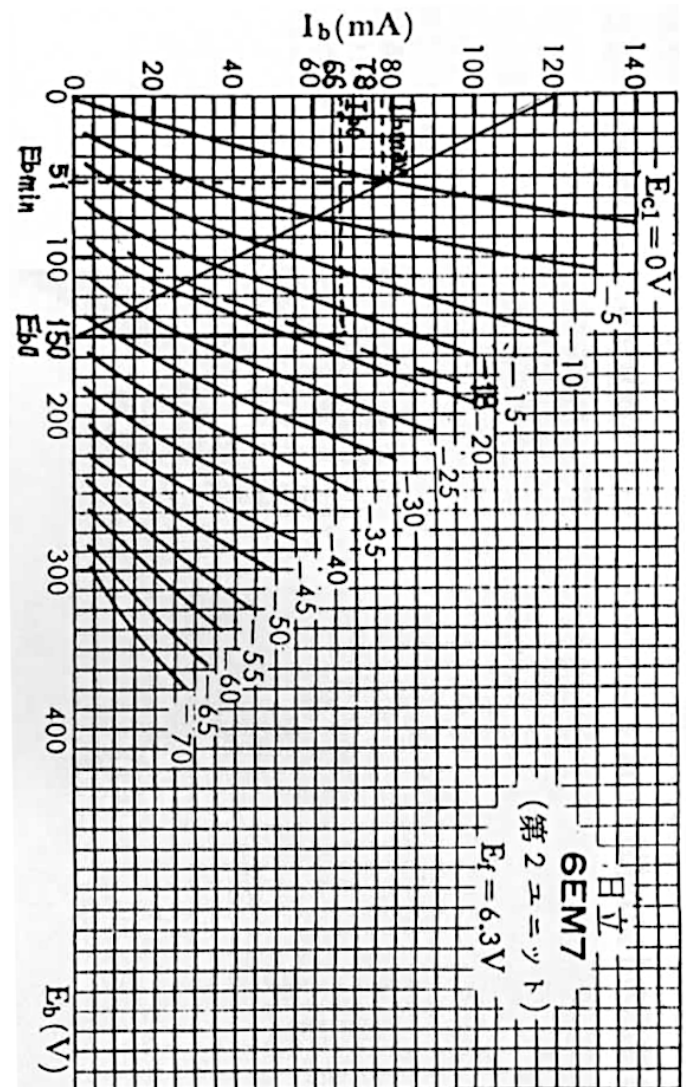
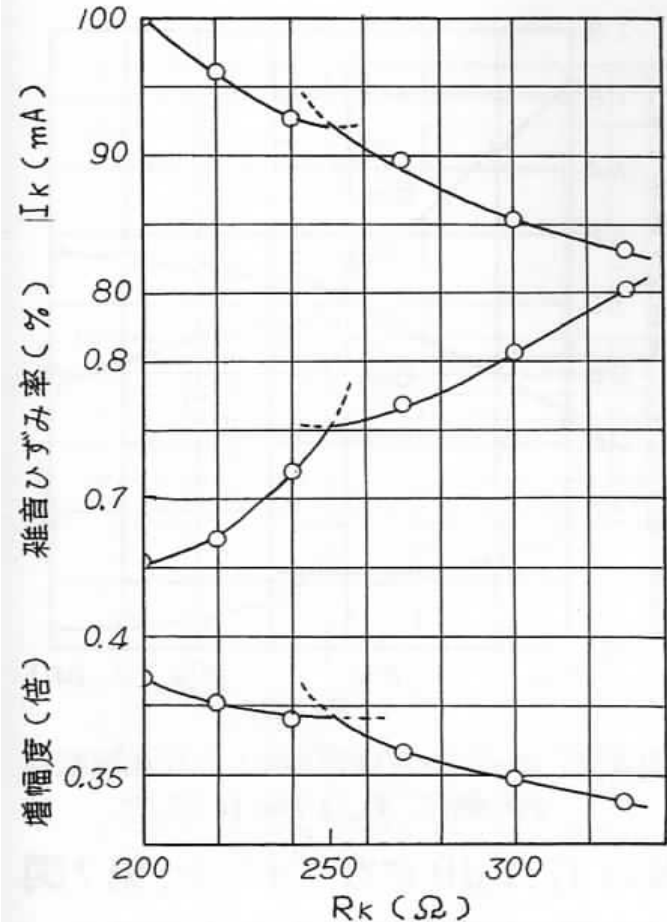


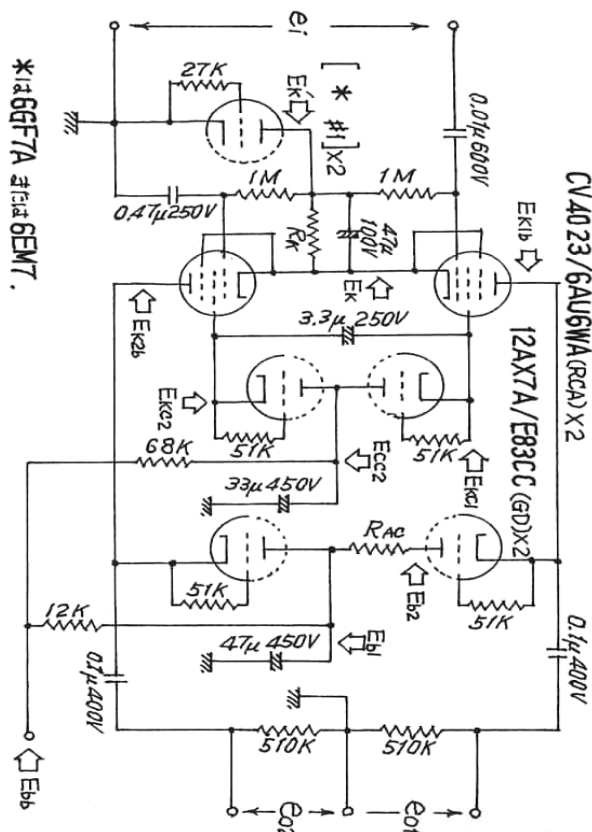
Fig. 1: Determine the operating point using the E_b - I_b characteristic of 6EM7

There's no one for the 6GF7A. In the RCA manual for the 6GF7A, it says that the E_b - I_b curve for unit 2 is 6, & the E_b - I_b curve for the 6EM7 is 6.

Fig 1 shows a load line plot with a plate voltage of $E_{b0}=150V$ at rest & a load resistance of $R_L=5k$. The values shown in Fig 1 & the values obtained by calculation are summarised in Table 2. From this, the max output is 3.8W, & the plate loss at this time is 4.6W.



(Fig 2) R_k value & operation of power tubes



(Fig. 3) 6GF7 Vacuum tube resistance values for A-PP amps ± Exposure circuit

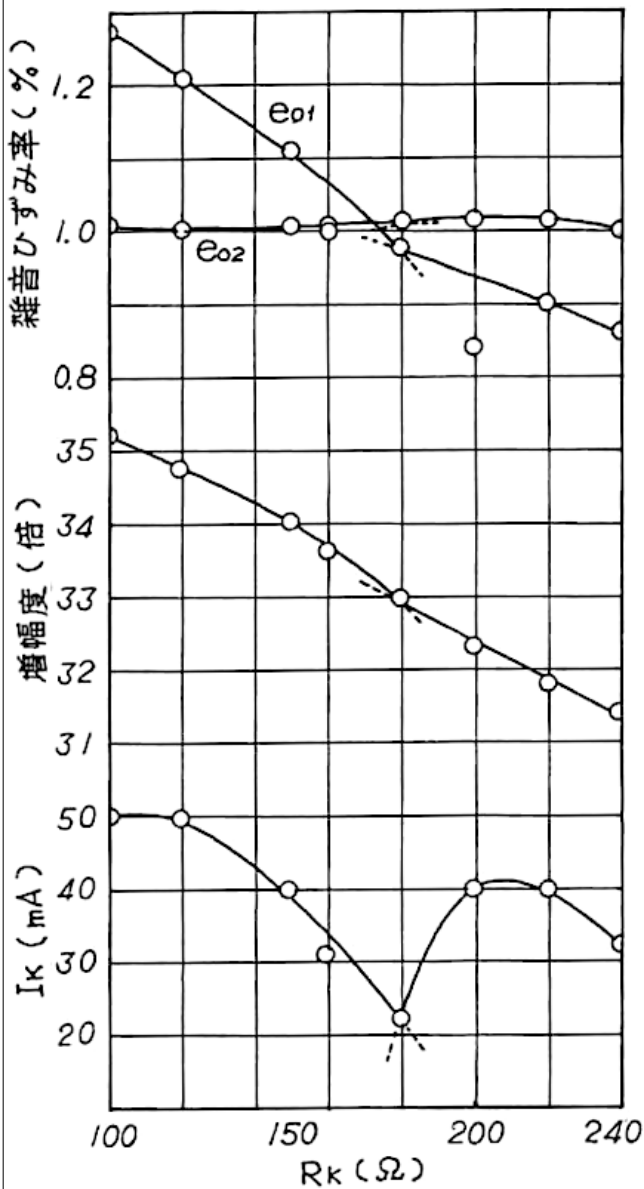
R_k	E_k	E_k	E_{bb}	E_{b1}	R_{ac}	E_{b2}	E_{k1b}	E_{k2b}	E_{cc2}	E_{k1c}	E_{k2c}	e_{o1}	η_{o1}	e_{o2}	η_{o2}	I_k	e_i	増幅度
(Ω)	(V)	(V)	(V)	(V)	(kΩ)	(V)	(V)	(V)	(V)	(V)	(V)	(V)	(%)	(V)	(%)	(mA)	(V)	(倍)
100	99.1	98.6	294	256	0.534	258	155	152	205	150	150	7.47	1.27	7.46	1.06	5.0	0.221	35.2
120	99.0	98.4	286	258	0.744	259	157	154	207	152	152	7.42	1.21	7.42	1.03	5.0	0.213	34.8
150	97.0	96.4	291	255	0.744	256	156	154	207	152	152	7.39	1.11	7.39	1.10	4.0	0.217	34.0
160	96.8	96.3	293	257	0.744	258	157	153	207	152	152	7.37	1.03	7.37	1.11	3.1	0.219	33.6
180	95.6	95.0	290	255	0.510	256	157	154	207	153	154	7.39	0.978	7.40	1.14	2.2	0.224	33.0
200	94.2	93.4	289	254	0.954	255	157	156	209	155	156	7.42	0.837	7.42	1.16	4.0	0.230	32.3
220	94.6	93.7	289	256	0.954	257	159	158	210	156	158	7.40	0.904	7.40	1.15	4.0	0.233	31.8
240	95.7	94.6	296	261	0.954	262	164	161	213	160	160	7.47	0.857	7.41	1.04	3.7	0.236	31.4

(Table 3) Relationship between the constants of each part of the circuit in Fig 3 & the operating characteristics

The max rated plate loss is 11W for the 6GF7A & 10W for the 6EM7, so there is still some margin for both.

1. 6GF7APP Amp

(1) Optimal value of output tube cathode resistance R_k

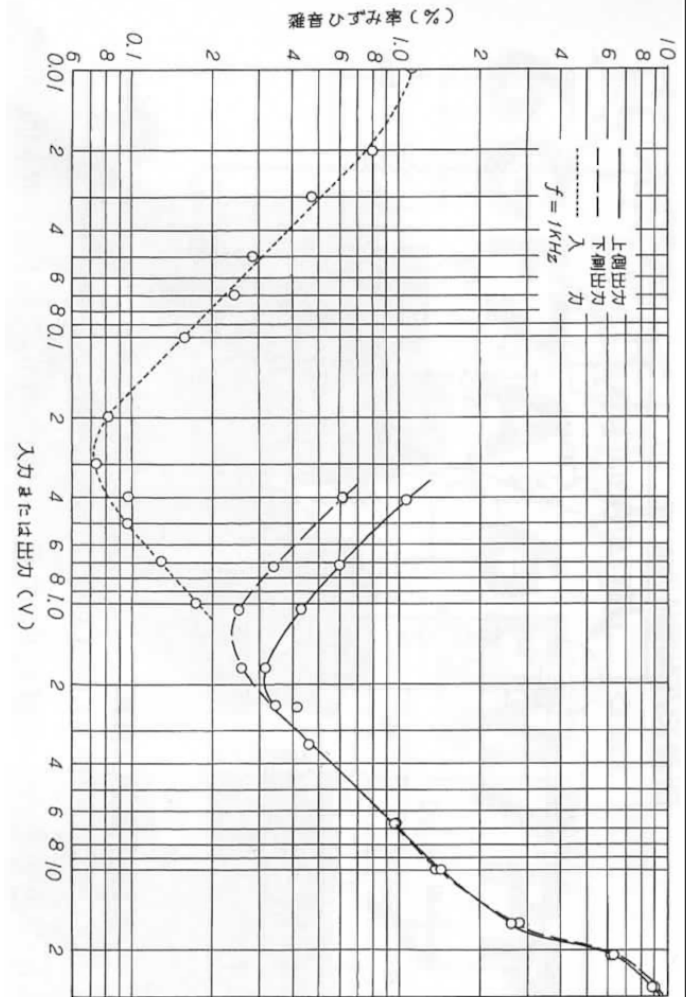


(Fig 4) Operation of the phase inversion circuit

The optimal value of R_k for the output circuit is 1.0W/1kHz. From the measurement results in Fig 2 at, the value was 250 Ω , but in the actual implementation, it was 240 Ω .

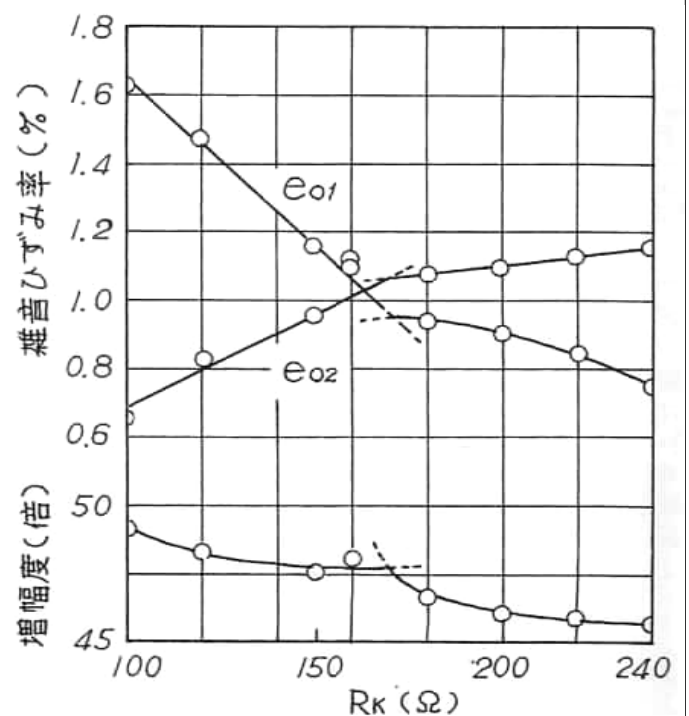
(2) Appropriate value of R_k for the phase inversion circuit
From Fig 4, which was created from the measurement results (Table 3) of the operating characteristics of the phase inversion circuit (Fig 3) at an output of 1.0W/1kHz, the appropriate value of R_k was 180 Ω , but since I didn't have any resistors on hand, I implemented it at 160 Ω .

Fig 5 shows the distortion rate of the phase inversion circuit. Comparing Fig 5 with Fig 6, which was created from a measurement taken three days before this measurement, we can see that the optimum value of R_k & the amplification at that time changed from 1700/47.8 times to 1800/33.0 times. Regardless of the change in the optimum value of R_k , we were surprised at the dramatic drop in amplification. 6AU6WA plate voltage



(Fig. 5) Distortion of the standard circuit shown in Fig. 3

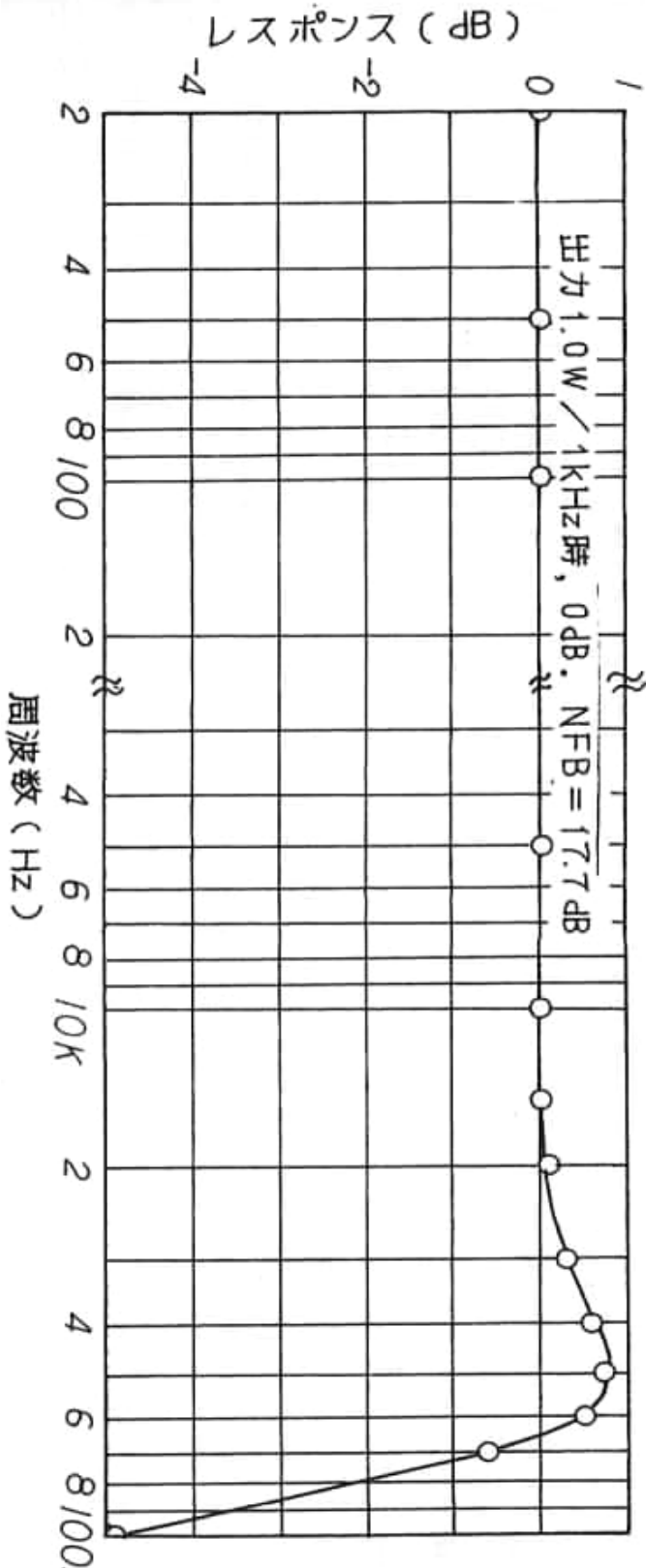
The change is so small that it can be ignored, so it is likely that the tubes were not aged sufficiently at the time of the first measurement. After assembling this unit, the amplification of this circuit was measured again & found to be 35.0 times.



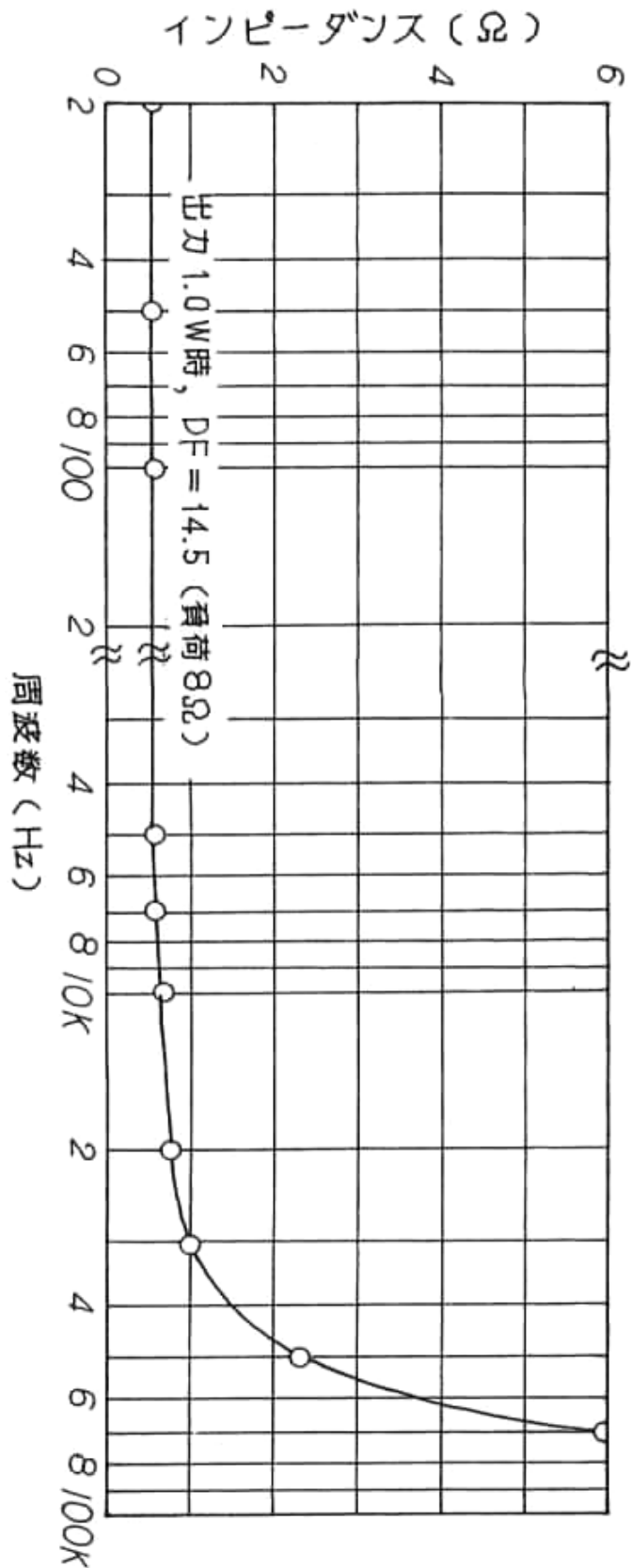
(Fig 6) Operation of the phase inverter circuit re-measured after aging. R_k was set to 160 Ω .

The required value of the AC balance resistor was 767 Ω , but the actual value was 766 Ω (620 Ω +150 Ω , measured value). The internal resistance of unit 1 (parallel connection) of the 6GF7A resistor tube was 21k2 Ω .

(3) R_k value of the first stage tube
The R_k value of the first stage tube was set to 360 Ω , & the amplification of the first stage circuit was 7.2 times. The negative feedback resistor value was set to 7k0 Ω (measured value of 6k8+200), & the negative feedback amount was 17.7dB. Figure 7 shows the circuit diagram of this unit.



(Fig. 17) 6EM 7 PP amplifier frequency generation

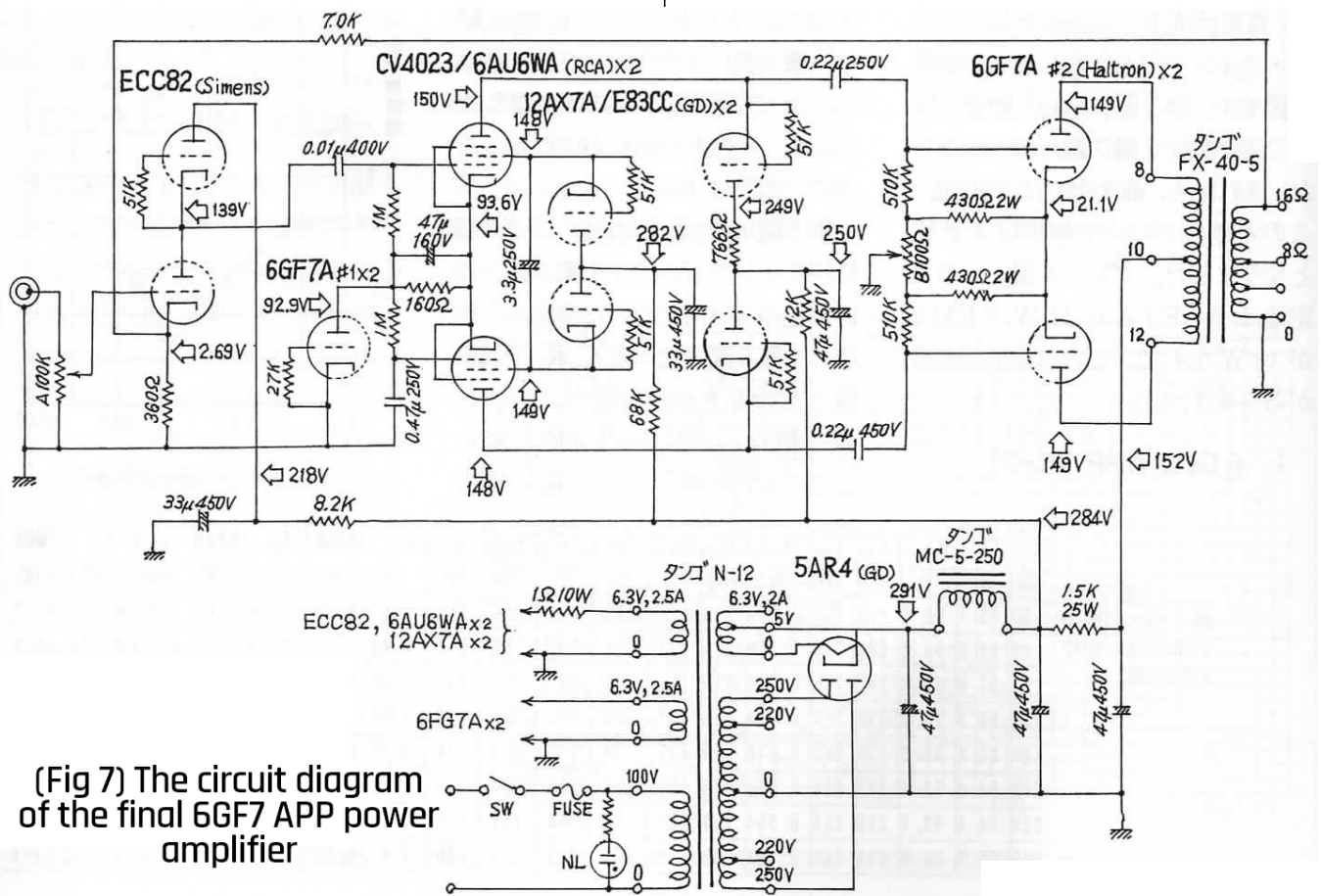


(Fig. 18) Custom-made output impedance for 6EM7PP amp

Various characteristics
Fig 8 shows the distortion rate characteristics of this unit. The maximum output was 3.2W.

After constructing this unit, I was able to get an RCA 6GF7A. Fig 9 shows how to replace it with this unit.

(Table 3) Relationship between the constants of each part of the circuit in Fig 3 & the operating characteristics

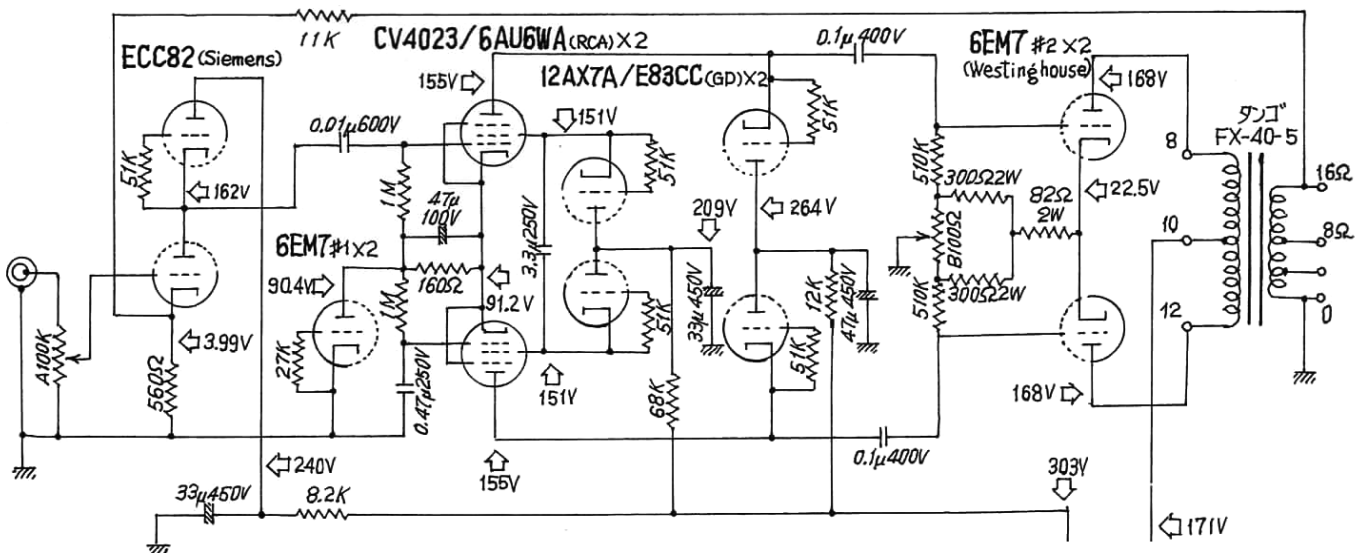


Various characteristics

Figure 16 shows the distortion rate characteristics, with a max output of 3.5W. The distortion rate characteristics showed an abnormality between 0.7W & 3W at 70Hz input, which was different from the other two curves.

Figs 17 & 18 show the frequency characteristics & output impedance Hitachi. Both of these figures show the 10th & 11th curves for the 6GF7APP amp. The result was very similar to that shown in Fig 11.

Fig. 15: Circuit diagram of 6EM7PP amp (power supply is the same as Fig. 7)



So we investigated the distortion rate at 70Hz in the phase inversion circuit (Fig 14), & since there was no abnormality in the distortion rate at 70Hz, we determined that the abnormality in Fig 16 was due to the inherent characteristics of the 6EM7 used. Apart from this point, Fig 16 could be superimposed on Fig 8, which shows the distortion rate characteristics of the 6GF7APP amplifier.

That is, the frequency characteristics increased to the right, with a peak of 0.67 dB at 50 kHz, but as with the 6GF7APP amplifier, no high-frequency correction was applied.

The output impedance Z_o was 0.550 between 20Hz & 5kHz at output 1.0W, & the damping factor DF in this case was 14.5 at a load of 8Ω. These Z_o & DF values were the same as those for the 6GF7APP amp.

The sound was almost the same quality

When one channel of the playback line was connected to a 6DE7PP amp & the other channel was connected to a 6GF7APP amp or a 6EM 7 PP amp, the playback sound did not feel strange in any case, & it was determined that the playback sound of the three was the same quality. This was as expected.

So far, seven of the ten types of double triodes for vertical oscillation deflection have been used, & the unused ones are 6CY7, 6FD7, 6FY7, & 6FY8, but I suspect that the sound quality of these will be the same as the above three.

Vertical deflection double triodes are cheaper & easier to obtain than double triodes for the same purpose (6AH4, 6BL7, 6BX7, 6CK4, etc.), so I think they should be used more often.