ETF 2009

November 2009

FOREWORD

An event such as the European Triode Festival fills my heart with happiness and hope. I have great respect for solid state devices and the progress they allowed, but I have always refused to believe that the world of audio valves was dead.

Every year a hundred people meet to demonstrate their trust and passion. I hope this event will expand and be joined by many more, including those prevented from coming because of their work commitments, that have become so demanding in recent years.

For over twelve years, after retiring, I have dedicated most of my free time to resume my passion for audio electronics, that conquered me since I was 10 years old. Immediately faced with the huge scale of my project, I had no other choice but to concentrate on a limited selection of issues. Therefore I took a drastic attitude, summarized in a few research objectives.

At first I brushed up my knowledge reading some basic books (1) and re-discovered a lot of almost forgotten concepts and formulae (2). I spent quite a lot of time examining the existing schematics of classic audio amplifiers and attending some forums where experienced audiophiles discussed their beliefs.

Finally, I felt I was able to make up my mind.

Here is what I decided:

1) concentrate on single ended topology
2) use triodes and not penthodes or tetrodes
3) use direct couplings avoiding the resistance/capacitance problems
4) no overall negative feed back, just local feed back
5) use good quality capacitors just for filtering, snubbers and in parallel with electrolytics.
6) reduce number of stages
7) reduce number of components
8) avoid use of types of valves difficult to find
9) study the output transformers behaviour and see if it could be improved.

In other words, simplifying, speeding up the movement of the signal from the input to the output, and removing any disturbing obstacle (with the capacitors in mind) and improving the damping factor. The overall effort included innovating as much as possible the classic circuits, wherever possible, without worsening their performance.

The first official result was a certificate (3) granted by the French National Institute of Industrial Property (INPI) regarding the early D.C.M.B. layout (Direct Coupling Modulated Bias). In early 2000 the magazine Glass Audio, now AudioXpress, published my first article : “A universal Phase Splitter.”

The present work concerns the Direct Coupling Modulated Bias system extended to an application: the Simplex Single Ended amplifier, whose description first appeared in 2001, in the e-magazine of the site Bottlehead.com (Valve magazine). Since then, this amplifier has been duplicated hundreds of times by do-it-yourself audiophiles, all over the world.

The Simplex is not complicated and needs an extremely limited number of active and passive components, as you will discover reading the following pages. So much benefit for the cost and reduction of possible mistakes.

All you need to do is readjust your knowledge from the digested classic circuits to this novel one, that does look somewhat familiar, due to its resemblance to the circuit of Loftin and White.

Please do not think that the DCMB is just a copy of the above. The apparently slight changes introduced have made a lot of difference. You can discover them easily; just keep in mind two main points:

a) There is no common negative line between the driver and the output stage.
b) In fact, the DCMB requires two separate power supplies, and they are stacked, that is the negative line of the upper power supply (the power valves' supply) is connected to the positive pole of the lower one (the driver's). Be careful not to forget that (4)!

Some additional advices I must give are as follows:

- Do not build a crowded amplifier, use a generous surface chassis.
- The Simplex uses one 6SN7GT valve and one 6C33C-B per channel. Keep these valves no more than 6 cm (max. 10 cm) apart, so that the connections do not become too long.
- Do not try to make changes if you are not absolutely sure they are sound. If you believe that your alternatives are worth consideration, please contact me. Please do not forget that I have been working on this unit for many long years.
- A good solution, in order to avoid making mistakes, is a very simple and inexpensive decision: use different colours for the wire connections (5).

This forward is followed by many files. Please pay attention to them. A resumé follows, to help understanding, if necessary.

I expect to publish soon, on my site (www.polisois-audio.com) the present paper, in French
.
Hope you will be interested in building the Simplex. Those who listened to it were very impressed. In order to benefit from the outstanding sound, use the best available output transformers. Recommended impedance: between 600 and 800 ohms.

Please do not hesitate to contact me at my e-mail address A2Belectronic@wanadoo.fr if you have any question.

Ari Polisois
November 2009

References and notes :

(1) Morgan Jones – Valve amplifiers - NEWNES
Menno van der Veen – Modern amplifiers from 10 to100W - ELEKTOR
Vivian Capel – Audio & Hi-Fi Engineers' pocket handbook. – NEWNES
and some others.
(2) Family and career as export executive first, assembling some kits, reading magazines now and then.

(3) This certificate does not compare to a patent. The latter implies that a worldwide research be conducted, before being granted. Later, the same Institute granted 4 patents concerning the compensation of the DC idle current in output and interstage transformers.

(4) I was confused myself, at the beginning.

(5) I suggest:

Brown = common wire between the two power supplies (negative line of the power stage and positive of the driver's)

Red = positive of the power stage

Yellow/green = negative of the driver stage – ground

Blue = anodes' connections

Green = grids (if the wire comes from an anode, use blue)

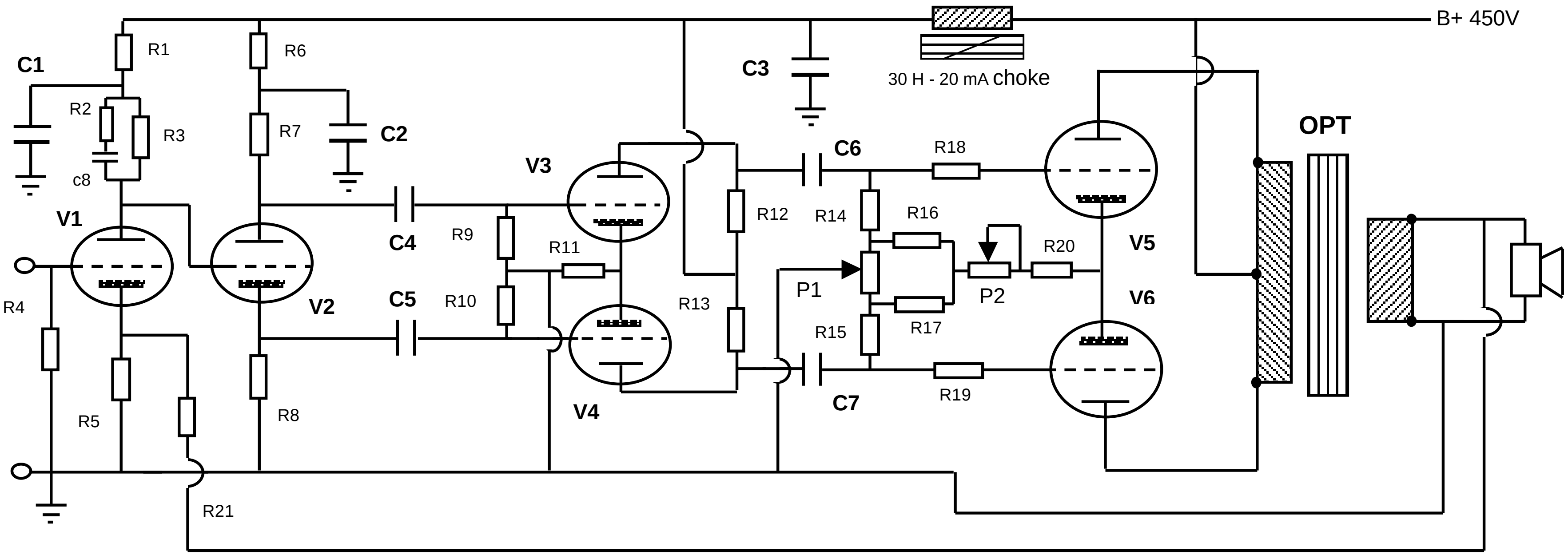
Yellow = heaters

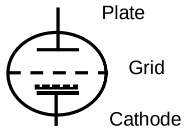
White = any other connection.

This means that you will instantly recognize the connections except for the white. It is a big advantage.

Fig. 1

GENERAL LAYOUT OF THE WILLIAMSON AMPLIFIER





V1 = 1/2 6SN7
V2 = 1/2 6SN7
V3 = 1/2 6SN7
V4 = 1/2 6SN7
V5 = KT66 triode mode
V6 = KT66 triode mode

R1 = 33k - 1W
R2 = 4.7k - 1/2 W
R3 = 47k - 1 W
R4 = 1 Mohm - 1/4 W
R5 = 470 ohms - 1/4 W
R6 = 22k - 1W
R7 = 22k - 1W
R8 = 22k - 1W
R9 = 470k - 1/2W
R10 = 470k - 1/2W
R11 = 390 ohms 1/2W
R12 = 47k - 2W
R13 = 47k - 2W
R14 = 100k - 1/4W
R15 = 100k - 1/4W
R16 = 100 ohms 1W

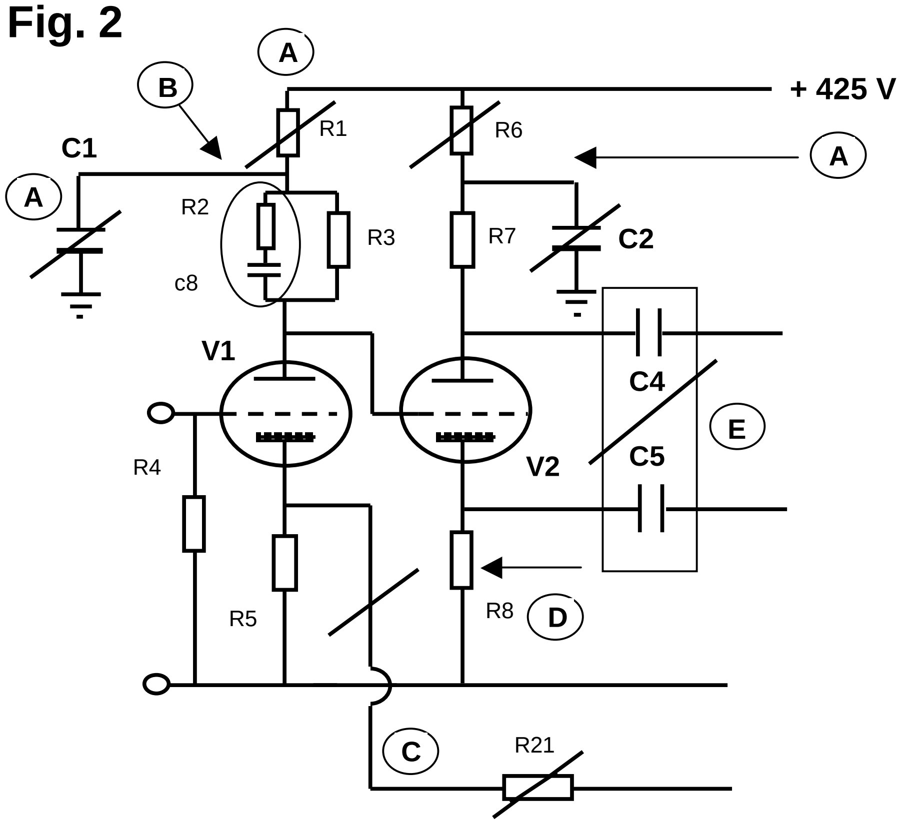
R17 = 100 ohms 1W
R18 = 1k - 1/4W
R19 = 1k - 1/4W
R20 = 150 ohms 3W
R21 = 2k4 - 1/2 W
P1 = 100 ohms 2W
P2 = 100 ohms 2W
C1 = 8µF - 600V
C2 = 8 µF - 600V
C3 = 8 µF - 600V
C4 = 47nF - 630V
C5 = 47nF - 630V
C6 = 220nF - 630V
C7 = 220nF - 630V
C8 = 220 pF - 630V
OPT = Push Pull output transformer

The Williamson amplifier had an **output power of about 15 W .** Negative feed back was necessary to reduce distortion to an acceptable figure. In some cases motorboating occurred due to the particular layout . Each section of this circuit will be analized separately , to discover its specific "weak" points. Remedies will be suggested for each "weakness".

COMPONENTS : 4 Valves & sockets - 21 resistors - 2 Pot. - 8 capacitors + 1 choke - 1 OPT - One 450V Power supply.

THE WILLIAMSON AMPLIFIER
Input and phase splitting sections.

Fig. 2



REFER TO CIRCLED LETTERS ABOVE

A) If we can make the circuit stable , we do not need R1/C1 and R6/C2 .
Result : Saving of 4 components .
Remember the electrolytic capacitor's life is relatively short (5000-10000 hours).

B) The high frequencies "trap" R2/C8 is useless, if we do not apply an overall NFB.
Result : V1 amplifies low and hi frequency signals without discrimination.

C) No overall negative feed-back . This line & limiting resistor R21 are suppressed.
Result : We have avoided the side-effects of the overall NFB.
Purists do not like at all using overall negative feed-back . The reasons will be explained in a later chapter.

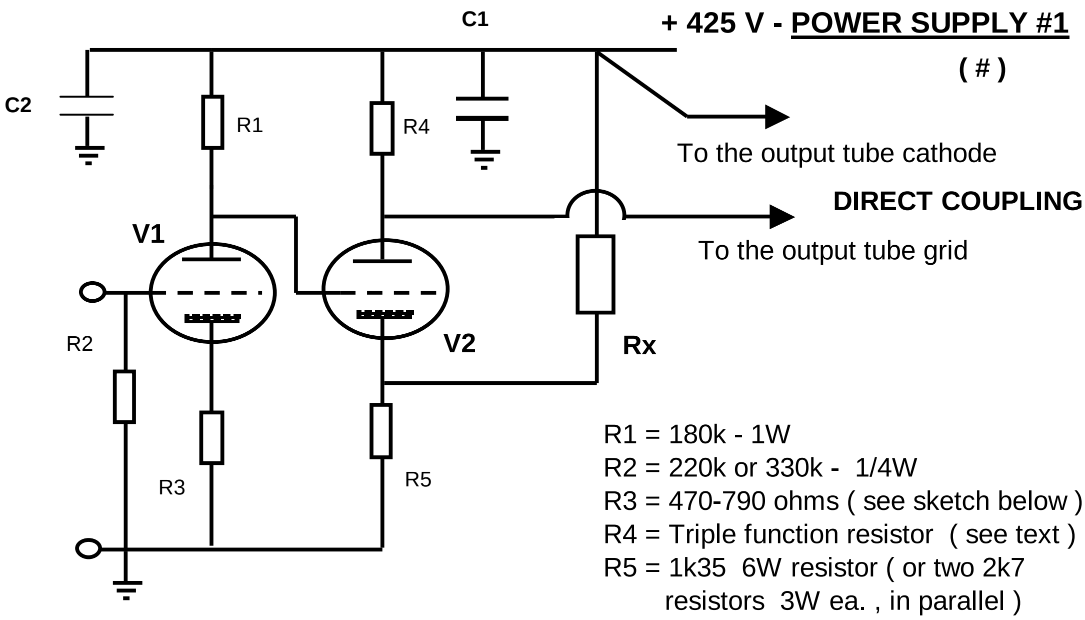
D) The DCMB will modify the value of R8 to a much lower figure .
Result : Section V2 amplifies 6-7 times more than the Williamson.
V1-V2 will amplify the input signal about 60 times , which is enough to drive the power tubes , thus making V3-V4 useless.
Hence : saving ONE tube and connected components
But also : One stage less , and this means less problems.

E) DCMB will do without the blocking capacitors C4-C5 , as well as the following resistors R9-R10 .
Result : faster path for the signal and reduced phase shift.

NOTE : The values of R3, R5, R7 and R8 will be modified, in the Direct Coupling Modulated Bias version .

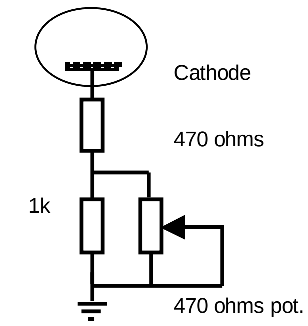
Fig. 3

THE D.C.M.B. VERSION of the Input and driver sections.



R1 = 180k - 1W
R2 = 220k or 330k - 1/4W
R3 = 470-790 ohms (see sketch below)
R4 = Triple function resistor (see text)
R5 = 1k35 6W resistor (or two 2k7 resistors 3W ea. , in parallel)
Rx = Extra current supply resistor 10K - 50W with heat sink
C1 = 330 to 450 µF / 450V electrolytic
C2 = 0.47 to 2 µF / 630V MKT or MKS hi-quality by-pass capacitor.
V1 - V2 = 1/2 6SN7GT .

R3 replaced by a limited variable resistance set



Variation = 470 to 790 ohms.

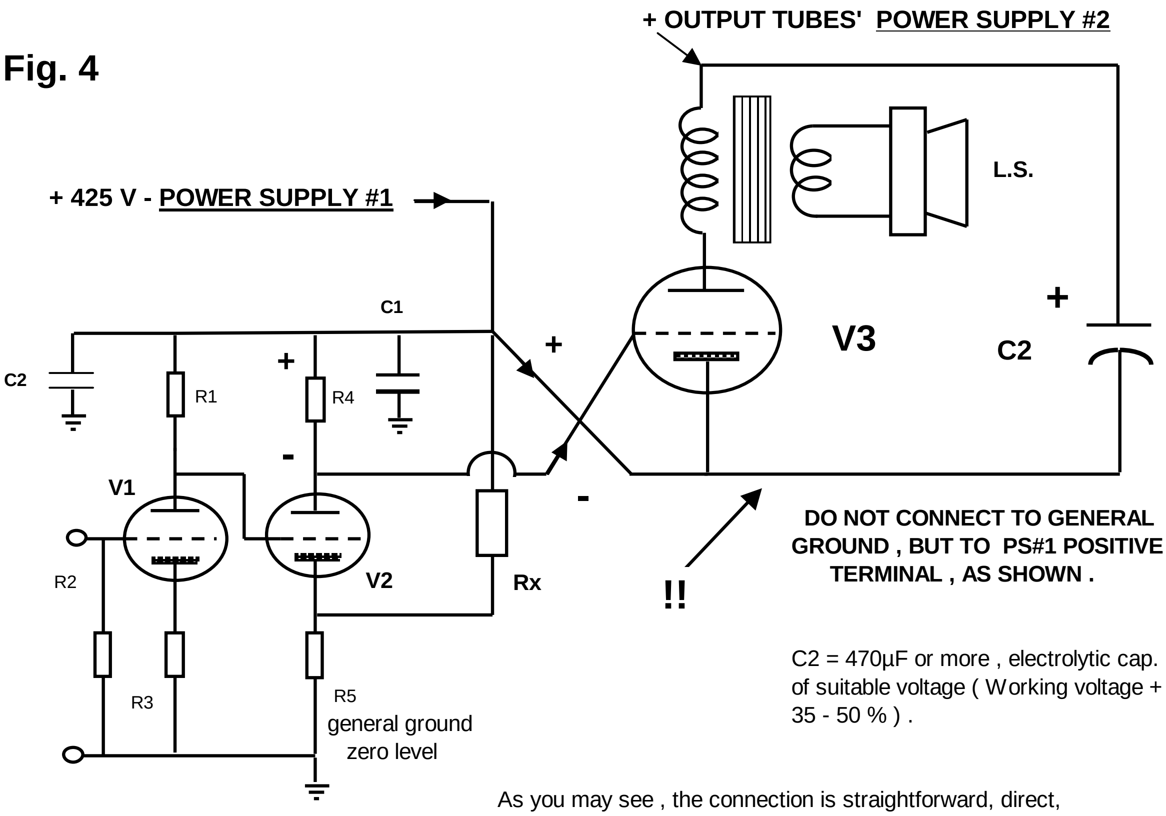
(#) We will see that the DCMB requires two distinct Power supplies : one for the driver section and one for the power tubes.

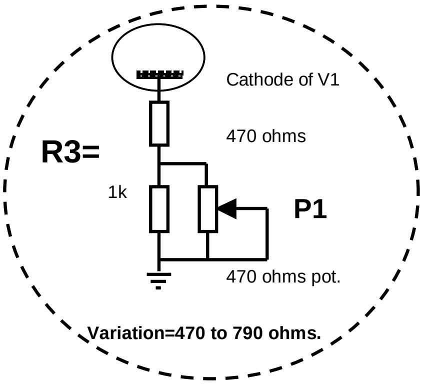
This driver can deliver over 60 V rms to the output tube , which means a peak signal of 84 V (168 V peak to peak) , enough to drive a 300B , a 6C33C-B or similar triodes to full power.
The direct connection will be explained in the next chapter .
As mentioned , R4 has a triple task :-
1. - Securing the necessary bias to the output tube
2. - Collecting the amplification of V2
3. - Transferring the ac signal to the grid and cathode of the output tube.

To comply with task #1 , the drop across R4 must correspond to the bias voltage required by the output tube .
Point 2 is easily understandable. Practically, a 6SN7GT can supply 60Vrms with 1V at V1's grid.
Point 3 will be made clear in the following chapter .

THE D.C.M.B. VERSION
Connecting the driver to the output tube

Fig. 4



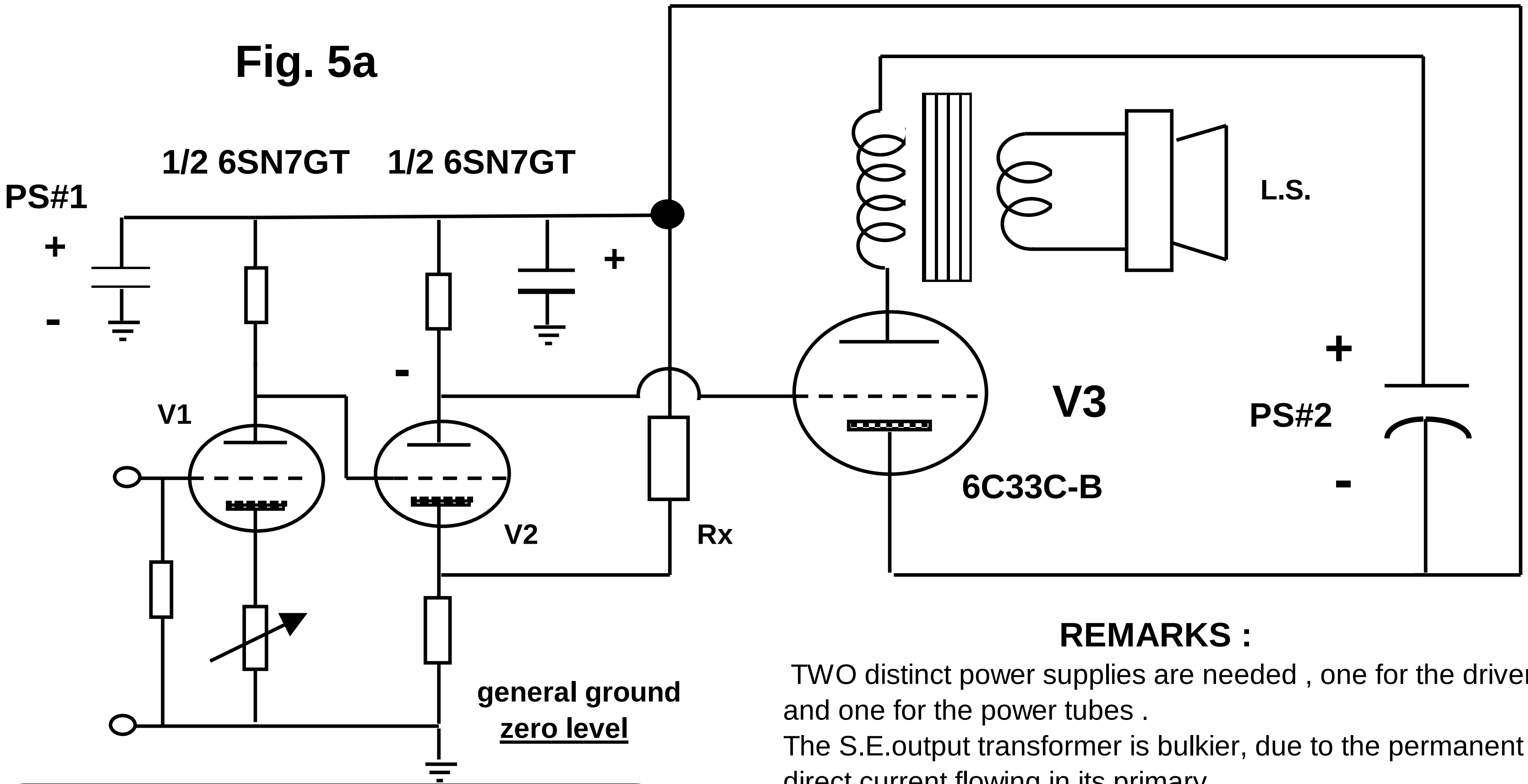


Surprisingly, the "R3" combination is very important. By changing the value of this cathode bias resistor set, the anode Volts of V1 change also, influencing the bias setting of V2 . As a consequence, the anode current of V2 changes as well as the Voltage drop across R4 .
It is easily understood, at this stage, that the voltage across R4 is also the bias voltage of the output tube .
To make a long story short , adjusting P1 will change the anode current of V3 thus permitting a setting within the recommended rates.

As you may see , the connection is straightforward, direct, with no frequency dependent obstacles (capacitors) .
The value of R4 is generally relatively low, thus assuring a good transfer of energy , without losses , to the output tube's grid.
As an example, if the anode current of V2 is set to the recommended value of about 9 mA , R4 will be 10k for a bias requirement of - 90V, which is,more or less, the level chosen for a 300B or a 6C33C-B , the two valves I generally prefer. Should V3 be a 2A3 (or several in parallel) , R4 can be reduced to 4k7 , thus ensuring the typical bias requirement for this tube (- 42.5 V) .
Note the polarity of the voltage drop across R4 . The negative corresponds to V2's anode and is connected via an absolute direct coupling, to V3's grid . The positive corresponds to the positive terminal of PS#1, the driver's power supply, but also to the negative of PS#2, the output tube's power supply, which is also connected, as normally required, to V3's cathode.
Under these circumstances, the necessary bias is fed to V3 and, at the same time, the full, untouched, swing of the signal amplified by V2.
Self bias (a power consuming device as well as an additional resistance in the power tube anode current path) is not necessary, as in the Williamson , and many other circuits.
The power tube internal resistance plays an important role in damping the loud speaker's cone excursions (a necessity to avoid booming), undirectly , though the output transformer primary/secondary mutual inductance. The lower the internal tube resistance, the better the damping factor. It is therefore obvious that, adding any extra resistance in the loop (B+ , primary winding , anode , vacuum , cathode , B-), such as a cathode self bias resistor, worsens the damping factor.
DCMB is therefore superior, also in this respect, and we will discover many other advantages.

THE SINGLE ENDED D.C.M.B. VERSION

Compared to the Williamson Push-pull.



THE SINGLE ENDED AMPLIFIERS' SONIC QUALITIES HAVE SPARKED LOTS OF DISCUSSIONS . THEIR SUPPORTERS ARE POSITIVE AND UNWILLING TO CHANGE .

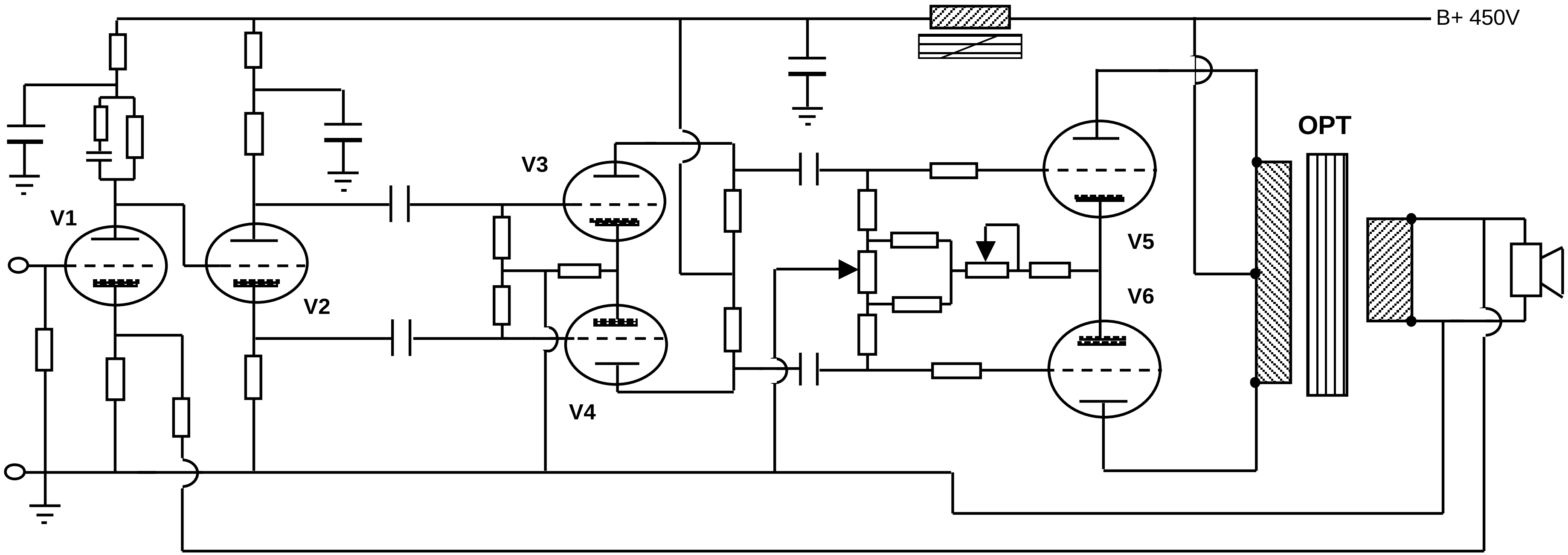
REMARKS :

TWO distinct power supplies are needed , one for the driver and one for the power tubes .
The S.E.output transformer is bulkier, due to the permanent direct current flowing in its primary .
S.E. output transformers for idle DC currents in excess of 200mA are not easy to find. However, a novel line of OPTs for Single ended amplifiers working at over 1 A of DC idle. current is now available (A2Belectronic@wanadoo.fr or www.polisois-audio.com).
See also ETF 2008 - Lectures.

15W output - One 6SN7GT and One 6C33C-B per channel - very few components. No capacitors from the input to the power tube. Easy to control. Stable. No overall negative feed back.

Fig.5b

GENERAL LAYOUT OF THE WILLIAMSON AMPLIFIER



It is quite obvious that the DCMB amplifier is definitely simpler than the Williamson .

One 6C33C-B , at 220 V plate voltage and 220 mA plate current, with a negative bias of 85 V , delivers 15 W of power with 5-6 % distortion, a very fast rise time, a minimum phase shift and, depending on the transformer used, a power frequency range (not the usual 1W safe measurement) larger than 20 Hz - 20 kHz.

From experience, the setting of R3 can take place once in a while , just to make sure that the plate current is about 220 mA (+ / - 5 %) . The Williamson setting is more elaborate and critical .

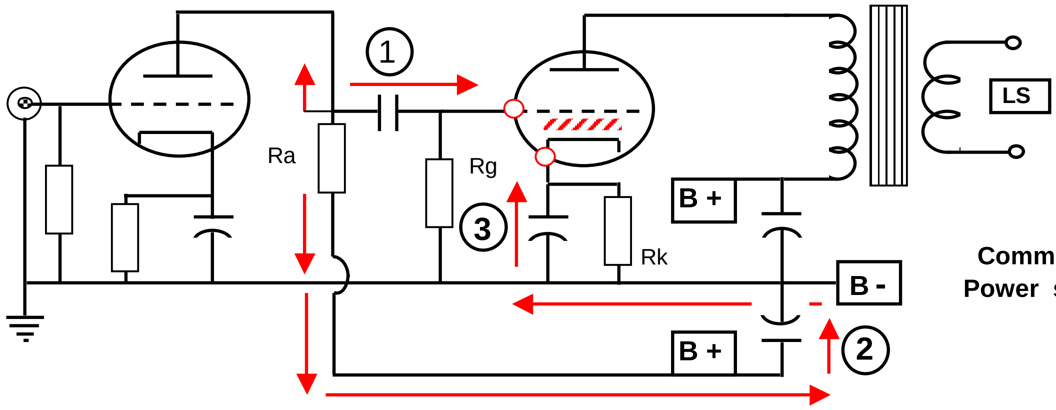
The DCMB can also be used with "special" tubes , such as the 845, 211 and similar , but it requires a very hi-swing driver . The output of one tube would then be 25 W approx. in single ended configuration . Particular requirements would be : very high power supply voltage (>1kV) and a suitable transformer (impedance 7k5 - 15k , insulation 5kV).

Tubes requiring lower bias voltages (EL34 , etc.) also need a special driver where V1 would be replaced by a valve with a lower operating plate current (for instance the 6SL7 or similar) .

Fig. 6

FREQUENCY DISCRIMINATION .

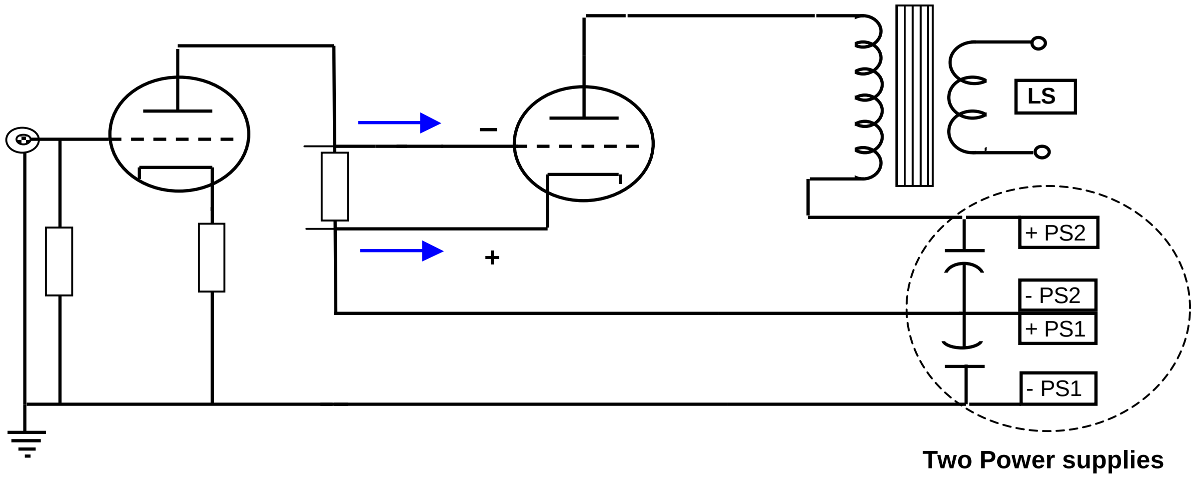
In the standard circuits , the signals usually cross three capacitors.



Common Power supply

The signals built up in the driver's load resistor "Ra" , cross "1" , from the upper side , to reach the output valve's grid . From the lower side , they have to reach the cathode of the power tube , so they first have to cross cap. "2" and then , if present (self biasing layout circuits) , cap. "3" .
This is quite a long and stressing trip . The capacitors oppose the AC a different resistance (reactance) depending on the frequency , according to the formula : Z = 1 / (2 x 3.14 x f x C)
where "Z" is in ohms ; "f" in Herz , "C" in Farads .
As an example , if Capacitor # 1 has a value of 0.22 μF , its reactance is 1 / (2 x 3.14 x f x 0.00022) = 36,190 ohms at 20 Hertz and only 36.2 ohms at 20 kHz . If Rg has a value of 100,000 ohms , the 20 Hz signal is reduced by a third , across the output tube's grid/cathode terminals , whereas the 20,000 cycle signal is received in its full amplitude .

WITH DCMB (DIRECT COUPLING MODULATED BIAS)
this does not happen .



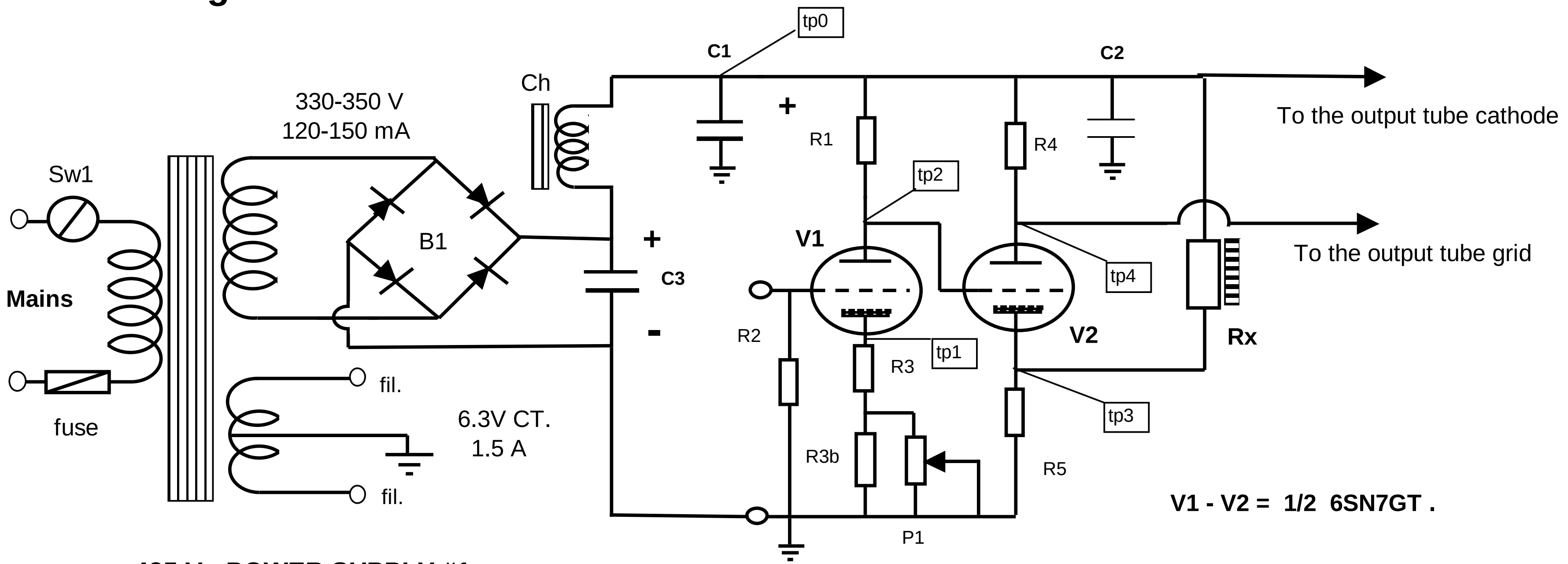
Two Power supplies

The absolute direct connection between the driver's load resistor and the grid/cathode of the following valve means no difference between Low and Hi frequencies . Every slightest variation of the signal is transmitted without loss , in Class A (*) .
The voltage drop across the driver's load resistor is also providing for the necessary bias to the output valve and is set to the correct polarity (minus to grid and plus to cathode) .

DCBM requires two distinct power supplies but , in return, has better sonic properties , simplifies the amplifier's circuit and reduces the number of components , especially the capacitors . Removing the blocking capacitors equals to reducing phase shifts .
(*) Where the output tube's grid never goes positive, with respect to its cathode.

UNIVERSAL DCMB DRIVER UNIT

Fig. 7



+ 425 V - POWER SUPPLY #1

R1 = 180k - 1W
R2 = 220k or 330k - 1/4W
R3 = 470 ohms 1/4 W
R3b = 1k 1/4 W
R4 = 10k - 4W
R5 = 1k35 6W resistor (or two 2k7 resistors 3W ea. , in parallel)
Rx = Extra current supply resistor 10K - 50W with heat sink

P1 = 470 ohms linear potentiometer.
C1 = 330 to 450 µF / 450V electrolytic
C2 = 0.47 to 2 µF / 630V MKT or MKS hi-quality by-pass capacitor.
C3 = 100µF - 500 V
B1 = Rect.bridge made of 4x1N4007 diodes, ea.shunted by a 10nF 1000V - MKS capacitor.
Ch = 5-6 Hy - 100-120mA choke.

TYPICAL VOLTAGES AT TEST POINTS

V to ground		Description
tp0	415-430	P.S.#1 positive terminal
tp1	1.7-2.5	V1 cathode (*)
tp2	60-65	V1 plate
tp3	66-77	V2 cathode
tp4	320-350	V2 plate

(*) depends on P1 setting & it varies the following voltages.

across R4	75-105	= power tube bias
Va1 to Vk2	minus 6-12	= V2 bias

BEHAVIOUR OF SEVERAL 6SN7s FITTED ON THE UNIVERSAL DRIVER

TEST # 1 : CHANGING THE BIAS OF V1 through P1

FIG. #8

#	BRAND AND TYPE	DC Volts across R4 Without signal				DC Volts across R4 With 0.66 V 1kHz				AC Volts across R4 With 0.66 V 1kHz		C/A	D/B	E/C	Ep/C	F/D	Fp/D
		A		B		C		D		E	F						
		R3a (*)		R3b (§)		R3a (*)		R3b (§)		R3a (*)	R3b (§)						
		Volts	Ia(#)	Volts	Ia(#)	Volts	Ia(#)	Volts	Ia(#)	Volts	Volts						
1	+ SOVTEK 6SN7GT	68	***7,6***	161	***17,9***	82	***9,1***	153	***17***	58	45	1,2	0,95	0,71	0,99	0,29	0,41
2	+ SOVTEK 6SN7GT	69	***7,7***	159	***17,7***	80	***8,9***	151	***16,78***	57	45	1,2	0,95	0,71	1,00	0,30	0,42
3	SOVTEK 6SN7GT	60	***6,7***	142	***15,8***	69	***7,7***	139	***15,44***	49	49	1,2	0,98	0,71	0,99	0,35	0,49
4	KEN-RAD 6SN7GT - VT231	61	***6,8***	148	***16,4***	70	***7,8***	142	***15,78***	51	55	1,1	0,96	0,73	1,02	0,39	0,54
5	+ KEN-RAD 6SN7GT - VT231	68	***7,6***	147	***16,3***	77	***8,6***	143	***15,89***	51	48	1,1	0,97	0,66	0,93	0,34	0,47
6	+ KEN-RAD 6SN7GT - VT231	73	***8,1***	161	***17,9***	84	***9,3***	153	***17***	55	44	1,2	0,95	0,65	0,92	0,29	0,40
7	KEN-RAD 6SN7GT - VT231	58	***6,4***	130	***14,4***	60	***6,7***	131	***14,56***	45	50	1,0	1,01	0,75	1,05	0,38	0,53
8	KEN-RAD 6SN7GT - VT231	63	***7,0***	146	***16,2***	71	***7,9***	142	***15,78***	49	51	1,1	0,97	0,69	0,97	0,36	0,50
9	KEN-RAD 6SN7GT - VT231	61	***6,8***	145	***16,1***	71	***7,9***	138	***15,33***	51	47	1,2	0,95	0,72	1,01	0,34	0,48
10	KEN-RAD 6SN7GT - VT231	64	***7,1***	148	***16,4***	72	***8,0***	139	***15,44***	52	46	1,1	0,94	0,72	1,01	0,33	0,46
11	6SN7 GTY CV 1988 6 K_IFE	54	***6,0***	144	***16,0***	65	***7,2***	136	***15,11***	52	51	1,2	0,94	0,80	1,12	0,38	0,53
12	6SN7 GTY CV 1988 6 K_IFE	49	***5,4***	140	***15,6***	61	***6,8***	134	***14,89***	51	53	1,2	0,96	0,84	1,17	0,40	0,55
13	SYLVANIA USA 6SN7 GT VT231	51	***5,7***	143	***15,9***	66	***7,3***	136	***15,11***	52	51	1,3	0,95	0,79	1,10	0,38	0,53
14	+ PHILIPPS ECG 6SN7 WGTA	82	***9,1***	172	***19,1***	88	***9,8***	150	***16,67***	60	40	1,1	0,87	0,68	0,95	0,27	0,37
15	+ PHILIPPS ECG 6SN7 WGTA	84	***9,3***	175	***19,4***	90	***10,0***	152	***16,89***	61	40	1,1	0,87	0,68	0,95	0,26	0,37
16	FIVRE 6SN7 GT	64	***7,1***	153	***17,0***	74	***8,2***	140	***15,56***	55	45	1,2	0,92	0,74	1,04	0,32	0,45
17	FIVRE 6SN7 GT	23	***2,6***	97	***10,8***	37	***4,1***	100	***11,11***	32	50	1,6	1,03	0,86	1,21	0,50	0,70
18	GE USA 6SN7 GTB	57	***6,3***	138	***15,3***	62	***6,9***	130	***14,44***	50	51	1,1	0,94	0,81	1,13	0,39	0,55
19	GE USA 6SN7 GTB	113	***12,6***	185	***20,6***	117	***13,0***	167	***18,56***	60	38	1,0	0,90	0,51	0,72	0,23	0,32
20	+ 6SN7 GTB RCA	72	***8,0***	159	***17,7***	80	***8,9***	144	***16***	56	41	1,1	0,91	0,70	0,98	0,28	0,40

(*) R3 set at 460 ohms (min.) **(§) R3 set at 955 ohms (max.)**

(#) Plate load resistor R4 of the second section of the 6SN7 consisting in 10k with 100K parallel resistor (= 9k).

TEST PROCEDURE : Several tubes of different brands, age, working hours , etc. were taken from the Laboratory stock and tested. The test consisted in setting the variable resistor P1 (see Fig.7) first at zero ohms and then at maximum (resulting in a cathode resistor value for the first section of the 6SN7 from 460 to 955 ohms). The voltage across R4 (the plate load resistor of the second section) was measured as stated in the column headings.

C/A = Ratio of the drop across R4 (also output tube bias) due to a.c. signal input , when R3 is at minimum
D/B = Ratio of the drop across R4 (also output tube bias) due to a.c. signal input , when R3 is at maximum.
E/C = Ratio of the swing (RMS) with respect to fixed bias (Volts across R4) , with R3 at minimum
Ep/C = Ratio of the swing (peak) with respect to fixed bias (Volts across R4) , with R3 at minimum
F/D = Ratio of the swing (RMS) with respect to fixed bias (Volts across R4) , with R3 at maximum
Fp/D = Ratio of the swing (peak) with respect to fixed bias (Volts across R4) , with R3 at maximum

SEE TEXT FOR COMMENTS ON THE RESULTS.

Valve # 19 is out of specs.

FIG. # 9

BEHAVIOUR OF SELECTED 6SN7s FITTED ON THE UNIVERSAL DRIVER

TEST # 2 : Measuring the voltages (to ground) at the test points .

TP0 =	**420 Volts** (B+ of PS#1)	**P1 adjusted for**	**90**	**Volts across R4a (R4a =**	**9 k-ohms)**
		Input to V1=	**0,72**	**Volts rms - at 1 kilo Hertz**	

#	BRAND AND TYPE	Channel	Cathode of V1 Tp1	Anode of V1 Tp2		Cathode of V2 Tp3		= bias of V2	Anode of V2 Tp4 (DC)		Anode of V2 Tp4 (AC) (RMS)		Peak	Gain
			Volts	Volts	mA	Volts	mA	Volts	Volts	mA	Volts	mA	Volts	X
1	SOVTEK 6SN7GT	L	1,09	52	2,04	61	45,2	-9,0	330	10,0	58	6,444	81,2	80,56
2	SOVTEK 6SN7GT	R	1,12	52	2,04	61	45,2	-9,0	330	10,0	58	6,444	81,2	80,56
4	KEN-RAD 6SN7GT - VT231	L	1,22	50	2,06	60	44,4	-10,0	330	10,0	56	6,222	78,4	77,78
7	KEN-RAD 6SN7GT - VT231	R	1,41	51	2,05	61	45,2	-10,0	330	10,0	52	5,778	72,8	72,22
20	6SN7 GTB RCA	L	1,06	50	2,06	60	44,4	-10,0	330	10,0	56	6,222	78,4	77,78
8	KEN-RAD 6SN7GT - VT231	R	1,26	49	2,06	60	44,4	-11,0	330	10,0	53	5,889	74,2	73,61
14	PHILIPPS ECG 6SN7 WGTA	L	0,98	52	2,04	60	44,4	-8,0	330	10,0	57	6,333	79,8	79,17
15	PHILIPPS ECG 6SN7 WGTA	R	0,98	52	2,04	60	44,4	-8,0	330	10,0	57	6,333	79,8	79,17

WHY THE ABOVE VALVES HAVE BEEN SELECTED :

Mainly because (with the exception of # 8 and 20) they were found compatible with each other or , in other words , matched.
Tubes # 8 and 20 were kept and tested, to compare their performance, in spite of the significant differences of their characteristics.

TEST PROCEDURE :

1. The supply voltage has been adjusted to 420 Volts (requiring an external resistor in series with the choke) .
2. The variable resistor P1 has been adjusted to read 90 Volts across R4a, the load resistor of the second section of the driver valve.
3. A 1 kilo Hertz , 0,72 Volts rms signal has been fed at both channels (Left and right) , simultaneously .
4. Tp1 , Tp2 , Tp3 , Tp4 have been measured with the meter set at "Direct Current reading" .
5. Tp4 has been measured again, with the meter set at "Alternating current reading" .

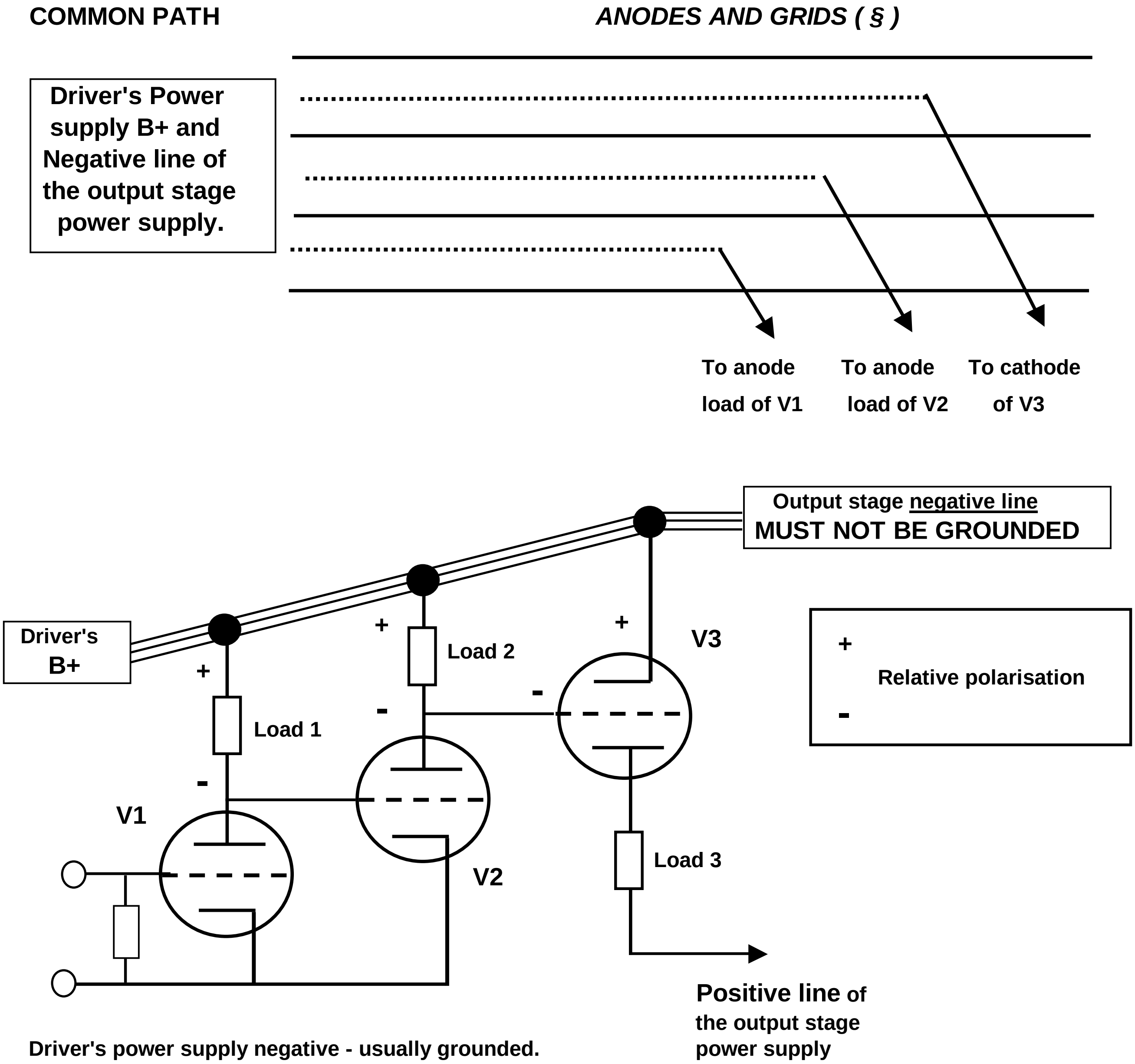
REMARKS :

a) Every valve required a different setting of P1 and, consequently, a different bias voltage, to produce a drop of 90 Volts across R4a.
b) The plate current of V1 did not change significantly , due to the presence of a high value (180 kilo ohms) plate load resistor.
c) The bias at V2 resulted between - 9 and - 10 Volts .
d) The plate current of V2 is the same for every valve , because the voltage drop across V2 was set at 90 V. , by adjusting P1.
e) The gain of the valves differ. Balancing volume controls would be required at the input . However , in Single ended amplifiers this unbalance results in a small difference of loudness between the two speakers (L and R), that is hardly noticeable
f) The effective working voltage of V2 is given by the B+ volts, less the drop across R4a, less the drop across the cathode resistors. Calculating : 420 - 90 - 60 = 270 V . The quiescent power dissipation of V2 is : 270 * 0,010 = 2,7 Watts , which is within the specifications of the 6SN7GT or 6SN7GTB tubes . Note that 0,010 A is the quiescent plate current (10 mA) .
g) The gain is excellent . Less than 1 V rms input will be enough to drive the output tube at full power in Class A (that is without driving its grid positive) .

Further tests will be made with these selected valves, in order to measure the frequency range and the distortion rate .
After these tests , the amplifier will be completed with the power section and measured as a whole .

Fig. 10 **D.C.M.B. CONNECTIONS**

OBSERVE : NO RESISTORS nor CAPACITORS BETWEE
ANODES AND GRIDS (§)



(§) Id est : the full signal (whisper or explosions) is transmitted between electrodes, wit
any <u>loss in ampliture nor frequency discrimination.</u>
Every change at Load 1, due to V1 being modulated by the input signal, is INSTANTL
transferred to Load 2 and collected by Load 3.

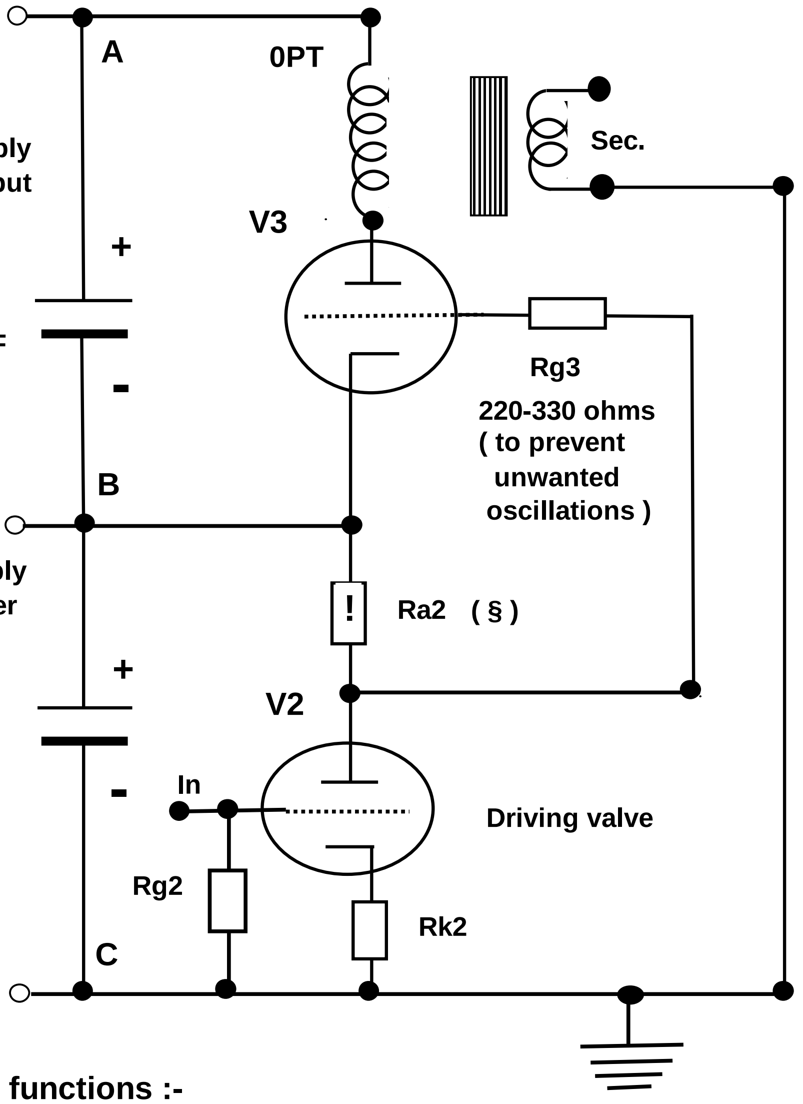
'N

hout

Y

AMPLIFIER WITH DIRECT COUPLING MODULATED BIAS CONNECTIONS

Fig. 11



(§) Three functions :-

1) the DC drop is used as bias for V2
2) anode load of V2 collects the ac signal
3) the signal is transmitted at max. amplitude and no frequency discrimination to the grid/cathode pair of V3

VOLTAGES : A to B must be the anode to cathode voltage required by the output tube.

B to C must be the overall voltage required by the driving triode.

This voltage is 420 to 430V for a 6SN7 and 390 to 400V for an ECC82/12AT7

The anode to cathode voltage will be the above voltage less the drop on the load resistor - less the cathode to ground voltage.

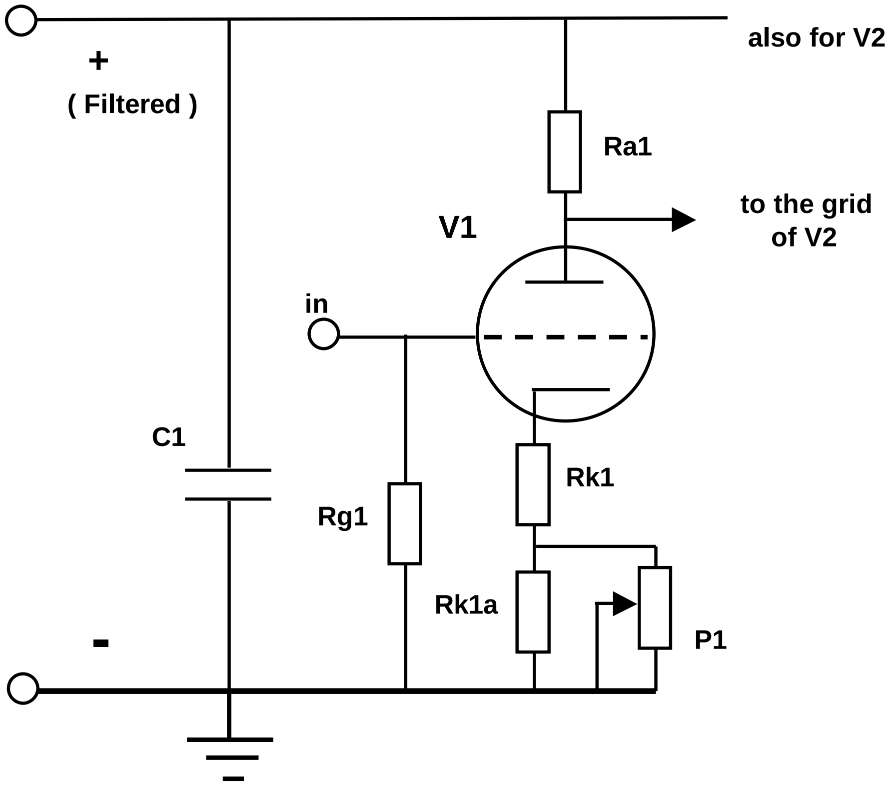
STAGE BY STAGE DESIGN GUIDELINES

INPUT TRIODE - Small signal amplifier

Fig.12

VALUES ARE FOR A 6SN7GT TRIODE

(they also apply to similar valves)



C1	**0,47 to 1µF - 630 or 1000V - good quality (MKT or MKS)**
Rg1	**220 to 330 kΩ - 1/4W**
Ra1	**180k - 2W**
Rk1	**Typically 330 or 470 ohms 1/4W**
Rk1a	**470Ω to 1k5 - 1/4W**
P1	**Linear pot. 470Ω to 2k2**

GAIN : Depending on the valve's characteristics the gain should be 13-15 times.
The B+ voltage suggested is 420 and above (up to 440V).
If 420V, the anode current is around 2mA and the anode voltage to ground = 420 - (180.000 x 0,002 A) = 60 V.
This potential will be applied directly to the grid of the following valve.
Rg1 can be replaced by a 47k or 100k audio pot (Log scale)
With a cathode resistor set made of 330Ω and a 1k pot shunted by a 1k resistor, the effective cathode resistance will go from 330 to 830Ω.
REMEMBER : The higher the resistance of this set, the higher the anode current of the output valve, as we will see later.
Therefore, Rk1 should be chosen so that anode current is not too high.

DISTORTION: Practically none. It starts only if :-
a) the input voltage (peak) exceeds the voltage of k1 to ground
b) the output of V1 should not exceed 10V peak, because the following valve cannot handle more, without generating higher distortion.

REMARK : This stage is not critical. V1 can be a suitable valve other than the 6SN7

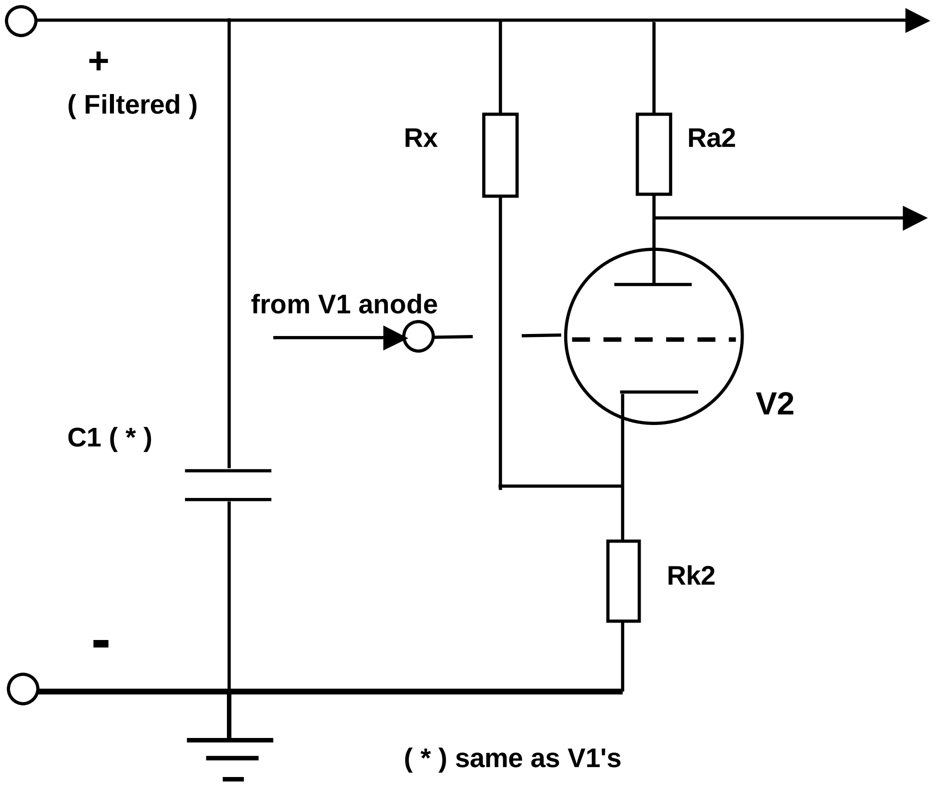
STAGE BY STAGE DESIGN GUIDELINES

driving triode - large signal amplifier

Fig. 13

VALUES ARE FOR A 6SN7GT TRIODE

(they also apply to similar valves)



C1	0,47 to 1µF - 630 or 1000V - good quality (MKT or MKS)
Ra2	10k - 3W
Rk2	Two 2k7 or 2k5 - 5W resistors, in parallel.
Rx	10k - 50W - Auxiliary current for Rk2, to raise its voltage to ground over the value due to the anode current.

GAIN : Depending on the valve's characteristics, the gain should be 4-5 times
The B+ voltage suggested is 420 and above (up to 440V).
V2's anode current is set by the bias, which is dependent on the difference between the DC input voltage, to its grid, received from the anode of the preceding valve (V1) and the voltage between the cathode (V2's) to ground. The grid input voltage is controlled by P1 (see #12).
The drop across Ra2 corresponds to the anode current multiplied by the value of Ra2. If this current equals 8,5mA, the drop will be -85V.
REMEMBER : <u>This drop corresponds to the bias applied to the output valve</u> (V3) through the direct connections shown in figure 4.
Rx dissipates about 12W so it must be a 25 or better a 50W resistor with heat sink, located in an open area, quite far from the capacitors.

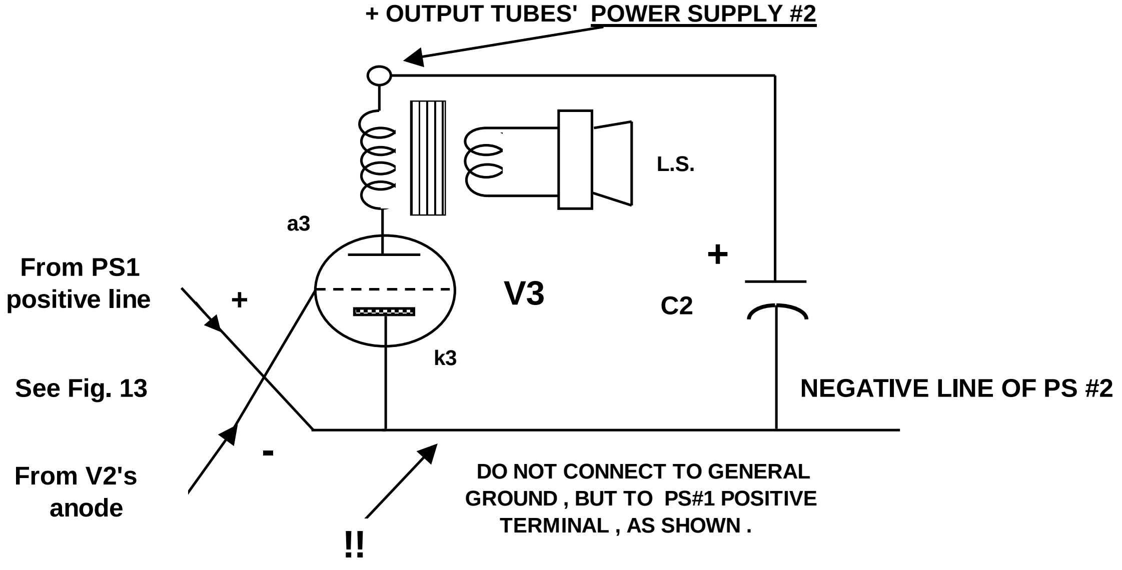
DISTORTION: Very low (2 % at 60-70V peak output). It starts only if :-
a) the ac input voltage (peak) exceeds the DC voltage of k2 to ground by more than a couple of volts
b) The fact that Rk2 is unbypassed, reduces distortion thanks to the local negative feed back. For this reason V2's grid can accept a higher peak ac signal than the value of the bias (which is equal to Va1-Vk2).

REMARKS : This stage is critical. V2 must be a suitable valve very similar to the 6SN7GT as regards the bias, the max.values (anode voltage and dissipation ability).
The above layout can be used for peak output signals up to 70-80 V.
If a higher output signal is required (such as 90 to 120V peak), some new solutions are now available. Please enquire.

STAGE BY STAGE DESIGN GUIDELINES

Fig. 14

Output stage - power amplifier
The Simplex uses one 6C33 and delivers about 15W
The Duplex uses two 6C33 paralleled and delivers 25W



C2 = 470µF or more , electrolytic cap. of suitable voltage (Working voltage + 35 - 50 %) .

Note the polarity of the voltage drop across Ra2 (the anode load of the driving tube (see Fig. 13) . It corresponds to the bias polarity required by the power tube.
At the same time, the full, untouched, swing of the signal amplified by V2 is transferred to V3.

Self bias (a power consuming device as well as an additional resistance in the power tube anode current path) is avoided.

The power tube internal resistance plays an important role in damping the loud speaker's cone excursions (a necessity to avoid booming), undirectly , though the output transformer primary/secondary mutual inductance. The lower the internal tube resistance, the better the damping factor. It is therefore obvious that, adding any extra resistance in the loop (B+ , primary winding , anode , vacuum , cathode , B-), such as a cathode self bias resistor, worsens the damping factor.

DCMB is therefore superior, also in this respect.

The use of DCMB, in my amplifiers, as a rule, has disclosed some additional advantages, that will be dealt with in a following paper.

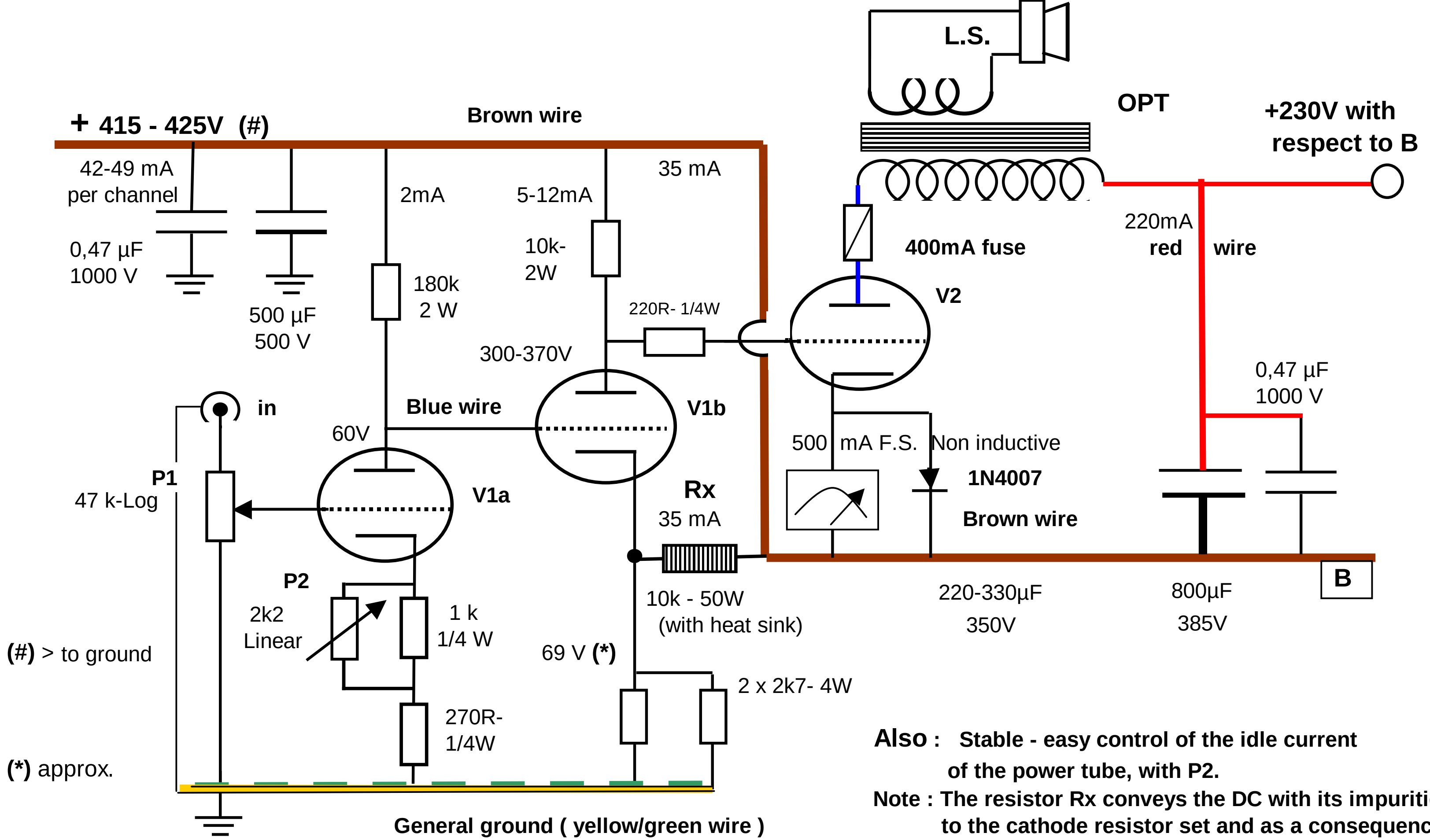
Ari Polisois ©

SIMPLEX - The basic circuit

2 Valves (three triodes) - 15W - 6,5% THD - 25 Hz - 25 kHz typical with a self compensated OPT.
Sensitivity about 0,7V for max. power output

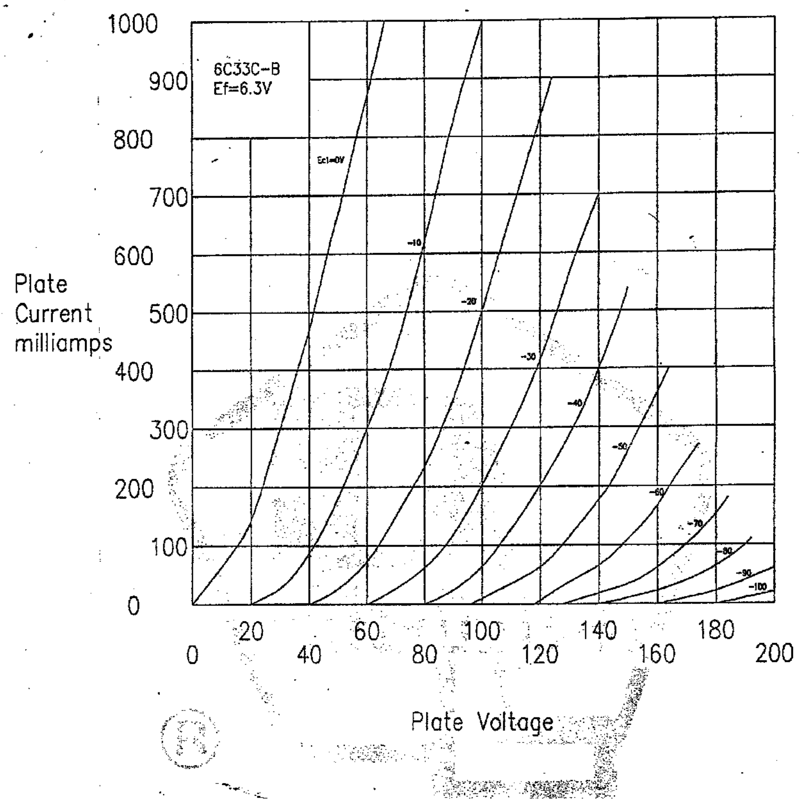
Direct Coupling Modulated Bias - no capacitors from input to V2's grid

Fast - Non discriminating - Simple - Excellent -



Also : Stable - easy control of the idle current of the power tube, with P2.

Note : The resistor Rx conveys the DC with its impurities to the cathode resistor set and as a consequence these are deducted (up to 25%) from the signal going to V2. It is a sort of DC negative feed back.


6C33C-B
Ef=6.3V
Plate
Current
milliamps
Plate Voltage
Ec1=0V
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
0
100
200
300
400
500
600
700
800
900
1000
20
40
60
80
100
120
140
160
180
200

D.C.M.B. driver unit tested for PS hum distribution at max. bias voltage (- 94 V)

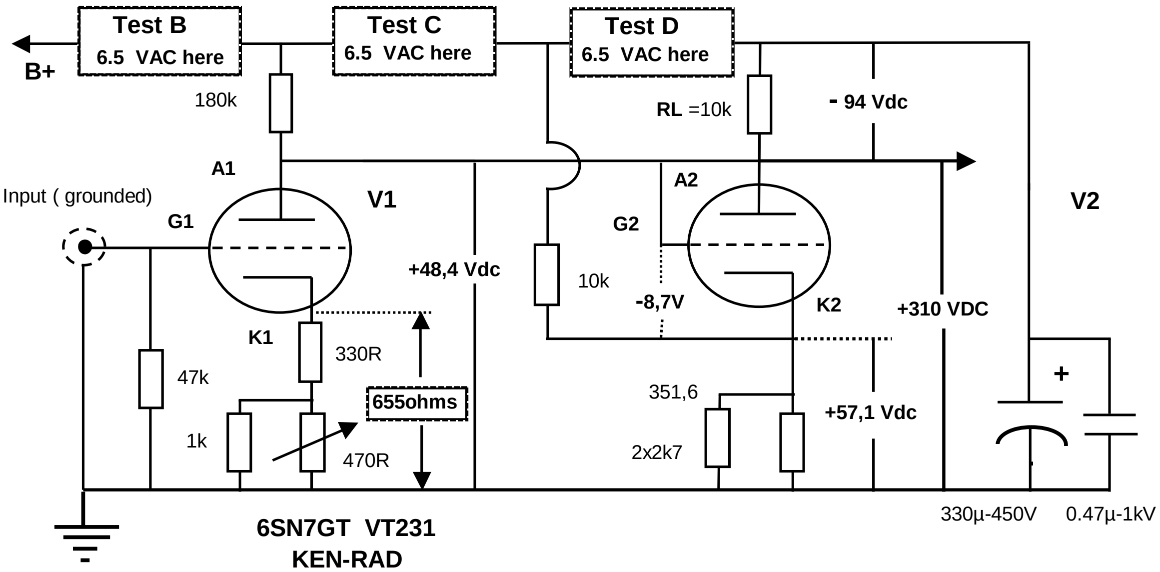
Fig.a
Appendix 1

Test A
B+ = DC only

Dec. 17, 2004

B+ = DC Volts with respect to ground

310



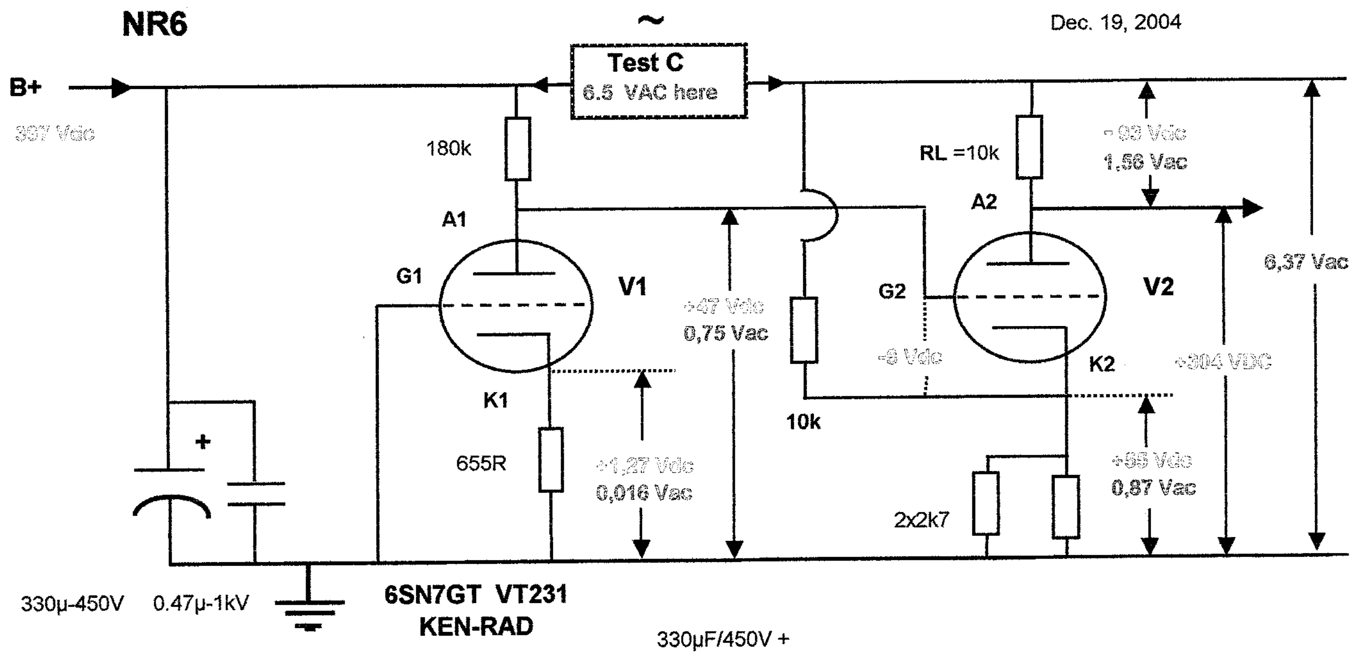
	Test A MAX		Test B MAX		Test C MAX		Test D MAX	
DC B+ TO GRD	404		=		=		=	
AC B+ TO GRD	0,021							
DC ACROSS RL	94							
AC ACROSS RL	0,0055		5,27		**2**		4,88	
DC K2 TO GRD	57,1							
AC K2 TO GRD	0,00225		0,6		0,52		0,175	
DC A1 TO GRD	48,4							
AC A1 TO GRD	0,016		0,77		0,11		0,13	
DC = BIAS	-8,7		0		0		0	
AC = NFB	0,01375		0,17		-0,41		-0,045	
DC K1 TO GRD	1,3		1,3		1,3		1,3	
AC K1 TO GRD	0,016		0,034		0,013		0,013	

Gain at 29 V rms output (corresponding to 41 V peak - almost minimum bias setting) **69** **18**
Gain at 66 V rms output (corresponding to 92,5 V peak - almost maximum bias setting) **70** **15,5**

AC A1 TO GRD		0,016		0,77		0,11		0,13	
AC K1 TO GRD		0,016		0,034		0,013		0,013	
A)	Ratio >>>>>	1,00		22,65		8,46		10,00	
	Rounded >>>	1		23		8		10	
AC ACROSS RL		0,0055		5,27		**2**		4,88	
AC A1 TO GRD		0,016		0,77		0,11		0,13	
B)	Ratio >>>>>	0,34		6,84		18,18		37,54	
AC ACROSS RL		0,0055		5,27		**2**		4,88	
AC K2 TO GRD		0,00225		0,6		0,52		0,175	
C)	Ratio >>>>>	2,44		8,78		3,85		27,89	

A) = Amplification of the hum between cathode and anode of V1
B) = Amplification of the hum supplied to V1 by V2
C) = Amplification of the hum resulting from B) less the NFB from V2's cathode resistor.

Driver unit tested for PS hum distribution at max. bias voltage (- 93 V)



330µF/450V +
0,47µF/1000V

		Test A	Test C
DC	B+ TO GRD	397	397
AC	B+ TO GRD	0,026	6,37
DC	ACROSS RL	93,5	93,5
AC	ACROSS RL	0,0055	**1,56**
DC	K2 TO GRD	55	55
AC	K2 TO GRD	0,00225	0,87
DC	A1 TO GRD	47	47
AC	A1 TO GRD	0,016	0,75
DC	= BIAS	-8	-8
AC	= NFB	0,01375	-0,12
DC	K1 TO GRD	1,27	1,27
AC	K1 TO GRD	0,016	0,016
DC	A2 TO GRD	303,5	303,5
AC	A2 TO GRD		4,78
AC	B+ before 6,5VAC to GRD		0,26
DC	ACROSS V1 LOAD		350
AC	ACROSS V1 LOAD		1.27

Nominal Gain at 66V rms output (corresponding to 92,5V peak (almost minimum bias setting)
70 (overall) **16** (first section)

Observe :

			DC+6,5 Vac
AC	A1 TO GRD		0,75
AC	K1 TO GRD		0,016
	A)	Ratio >>>>>	46,88
AC	ACROSS RL		**1,56**
AC	A1 TO GRD		0,75
	B)	Ratio >>>>>	2,08
AC	ACROSS RL		**1,56**
AC	K2 TO GRD		0,87
	C)	Ratio >>>>>	1,79

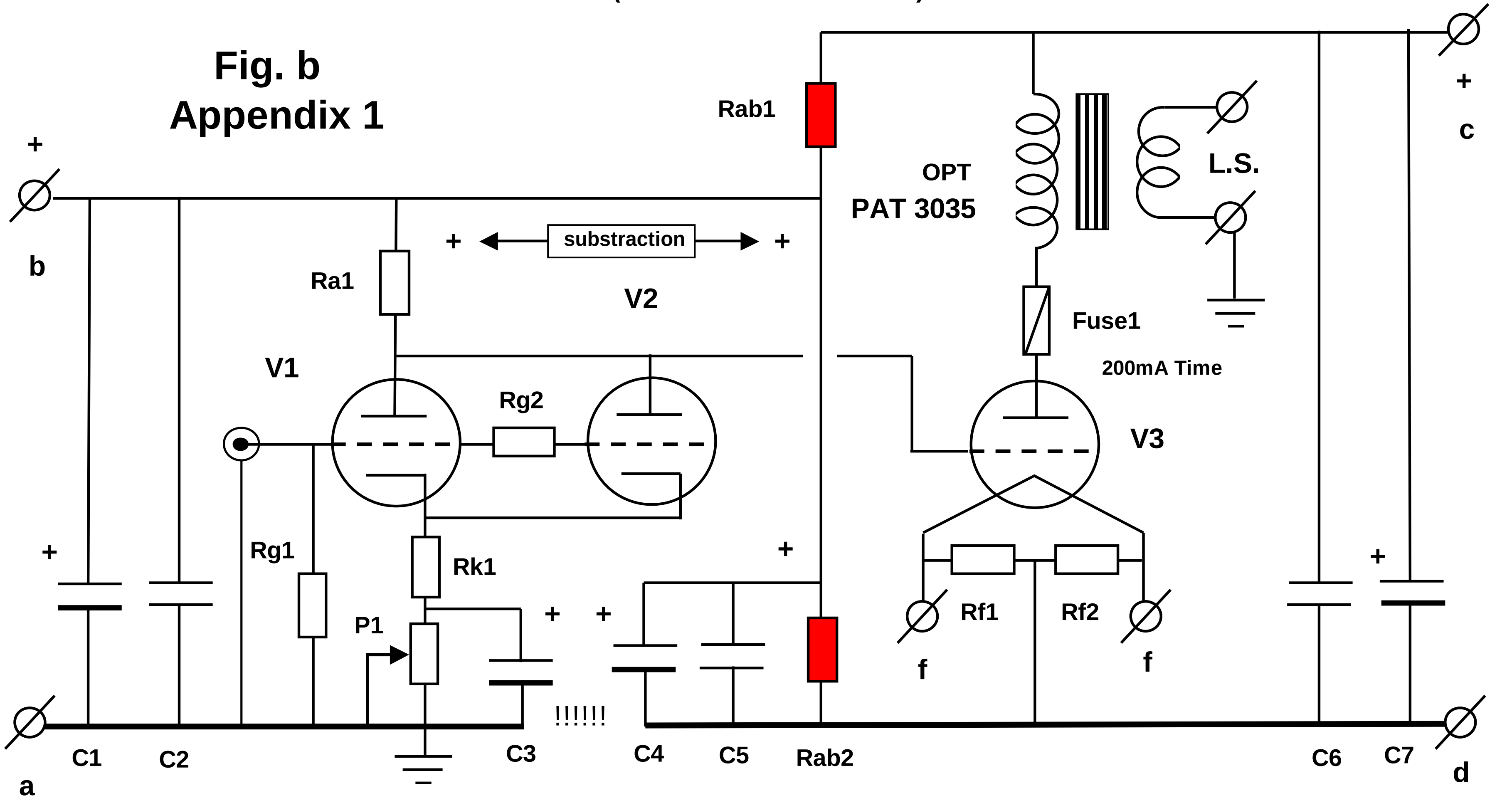
Some figures contain also hum flowing with plate current.

A) = Amplification of the hum between cathode and anode of V1 plus hum at the top.
B) = Amplification of the hum supplied by V1 to V2
C) = Amplification of the hum resulting from B) less the NFB from V2's cathode resistor.

"JOHNNY" a 300B - TWO STAGE D.C.M.B. AMPLIFIER

(as heard at the ETF 2009)

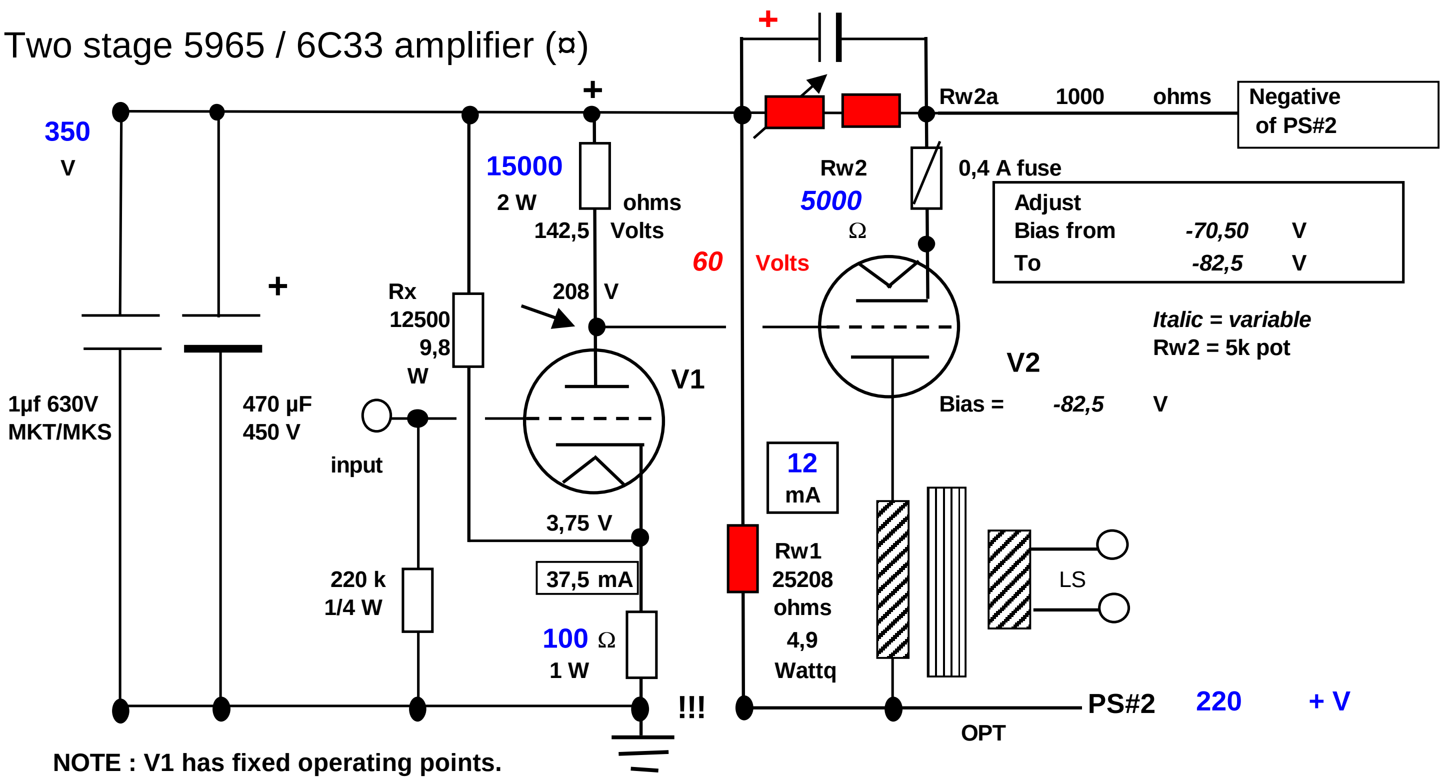
Fig. b
Appendix 1



a = ground	b = PS#1 +	c = PS#2 +	d = PS#2 -	a to b = V	c to d = V	Ra1 = ohms	Rk1 = ohms	P1 = average Ω	Rf1
				425 V	*350 V*	*30000*	*320*	*450*	*100 ohms 1W*
Rg1 = ohms	Rg2 = ohms	Rab1 = Ω	Rab2 = Ω	C1 =	C2 =	C3 =	C4 =	C5 =	C6 =
270000	*220*	*100000*	*10000*	*500µ-500V*	*0,47µ-630V*	*220µ-25V*	*220µ-100V*	*0,47µ-630V MKT*	*8µ-450V ac - MKT*
Valves - 1 triode	Type	µ	Ri ohms						
V1 & V2 =	*6SL7*	*78*	*44000*	Use delay relay to switch PS#2 power on.					C7 =
V3 =	*300B*	*3,6*	*800*						*330µF-400V*

Fig. C - Appendix 1

Two stage 5965 / 6C33 amplifier (¤)



NOTE : V1 has fixed operating points.

V1 anode current =	*9,5*	*mA*
Rx current =	*28*	*mA*
V2 anode current =	*220*	*mA*

Gain of the driver
without / with
local negative feedback

	Valves type	μ=	Ri=ohms	Ra=ohms	Rk=ohms	β= (§)	without	with Pre-amp.	
V1	*5965 (#)*	47	3150	15000	100	0,007	38,84	30,85	x
V2	*6C33*	2,6	100	600				29,8	dB

(#) two triodes paralleled

Input signal req.d to obtain a swing of 59 Volts = *1912* millivolts

μ = max.theor. Gain   Ri = internal resistance of the valve   Ra = anode load   (§) Ratio Rk/Ra

IN THIS AMPLIFIER THE DCMB VOLTAGE APPLIED TO V2 AS BIAS IS 142,5 v LESS THE 60 V OF THE ANTIBIAS NETWORK (Rw1 - Rw2 - decoupled by a suitable pair of capacitors)

(¤) Project - not yet tested .

Appendix 1 to the D.C.M.B. ETF 2009 File (Dec.15, 2009)

Following some questions raised by the presentation of the D.C.M.B. system, you will find herewith the following schematics :-

Figure A1 – Hum and noise reduction in a DCMB driver, resulting from the addition of Rx (all tests from A to D)
Figure A2 - Details on test C.

Figure B - Schematic of "Johnny" the 300B amplifier playing at the ETF

Figure C - Schematic of a project using a 5965 as driver (two paralleled triodes) and a 6C33C-B.

Comments

Regarding Fig. A1, the tests concern the hum and noise reduction operated by the resistor Rx of a typical DCMB driver unit. Said test has been suggested by a reader of Glass Audio, in 2004, Tom C.W., who called my attention on this feature.
The test consisted in putting a 6,3 Vac voltage in different locations of the DC supply line and measure the effects on the load resistance of the driver next to the power tube.
The results are shown.
Figure A2 is focussed on test C.
Herebelow what Tom wrote (e-mail dated Dec.19, 2004):-
" I assume 6.5VAC reduced to 6.34VAC due to the PSU capacitance + weird circuit interactions etc.
And by the way, 1,56VAC is an "excellent" figure, representing about 25% of total noise, hence "75%" noise reduction on the output compared to normal coupling methods.
I haven't carefully analysed noise cancellation in a push-pull circuit, but I doubt it is numerically much better than what your circuit achieves. Push-pull noise cancellation depends, for its integrity, not to mention its numerical value, on the degree to which the two tubes operate identically under dynamic conditions. No two tubes operate identically AND the two tubes amplify differently whether pushing or pulling (THD is a measure of this difference), leading to imperfect cancellation in a most unmusical manner. Add to this scenario the extra components involved (extra tube + resistors etc) and the coupling devices….. DCMB much better! "
Sorry, push pull fans, this is what Tom wrote, exactly and in full.

Figure B is the schematic of the 300B amplifier presented at the ETF this year. It was designed and assembled for a friend of mine, Johhny, living in Italy.
Compared to the basic schematic of the Simplex (sent with the previous file) it has two main differences :-

1) The driver consists in one stage only and uses the excllent valve 6SL7GT (of Sovtek manufacture). The two triodes are paralleled and the result is a lower load, required to drive the 300B at full power.
2) It does not need the auxiliary cathode current resistor Rx because part of the cathode resistors set is shunted by a capacitor. The local negative feed back that reduces the distortion has a resistance of 320 ohms and is not by-passed.

3) You will notice an uncommon resistor/capacity combination made by Rab1, Rab2 and some capacitors. The resistors belong to a voltage divider that, in the present case, produces a drop of about 32 volts acros Rab2.
4) You will also notice that this voltage is in series with Ra1, but with an opposed polarisation. As a consequence, the voltage applied to the output tube as bias, is reduced by these 32V and becomes -82,5 instead of –114,5.
5) The fact that my friend Johnny insisted to have a two-stage amp, forced me to use this topology (*) , with the aim to get as much gain as possible from V1 and V2, paralleled.
   However, the 6SL7 works well with approx. 2,5 mA of anode current and, at this rate, the 5mA of the paralleled triodes would make a drop of 150 V across the 30k common load, which is too high a bias for the 300B. Therefore, I dropped the anode currents as much as I could, without affecting the very low THD of the driver, and opposed what I named "the antibias" i.d. the 32 volts of Rab2 . The 300B now worked at about –85 Volts of bias and 350V of DC power supply.
   The use of the antibias answers a remark raised before, that in a DCMB driver the swing applied to the output tube can never be 0 volts because that would mean that the driver valve's anode current is zero (with all it implies). Now it could even go beyond.

The measurements made on this amp at the ETF have disclosed :-
Power output = 9,8 W
THD at 8 Watts in 8 ohms = 1,33 %
Frequency range –3dB at 8Vpp on 8 ohms = 7Hz – 45kHz
IMD at 1/8 W = 0,07%
Zout = 0,77 ohms.
The output transformers were Plitron's PAT 3035 single ended, designed by Menno van der Veen.
The valves were 300B Billington Gold. Later other valves were tried, without noticeable differences (JJ, Elektro Harmonix).
As you see, the amp worked satisfactorily, in spite or thanks to its simplicity.

Figure C
Encouraged by the result above, I have drawn a schematic involving the 6C33, with more or less the same circuitry.
One of the differences is the type of valves used in the driver unit, the 5965, a 47µ triode with 6k3 internal resistance, max. Ua 330V.
The reason is simple : I had just purchased some from Billington, at an affordable price.
Will they be suitable ? I'll found out.
It will not be difficult, as the driver stage, once the correct values found, can be optimized independently and the components's selection kept.
The adjustment of the output valve's bias will then depend on the 5K variable resistor setting (Rw2 and its associated resistor, in series, Rw2a). These two resistors, together, will dissipate less than ½ W and are located in a low sensitivity area.
By the way, before someone calls me to point out an unforeseen feature of the antibias, like Tom did with the Rx, let me ask you something:-

- have you noticed that the dynamic operation of the whole system has changed ?

As mentioned in the former paragraph, the valve V1 can now develop more gain, because of a higher anode load; but there is more.

V2, in conjunction with V1 is now working on the grid lines shifted to the left, which are less crouded and distorted than the extreme right ones.
If I am not wrong, this should mean less distortion, for the same power output.

I hope this new amp topology will work as well, if not better, than the one with the 300Bs, but, as you can imagine, I will not be able to confim this until next year.

Happy New Year to everybody and see you at the next ETF meeting.
Ari.

(*) in which some capacitors appear, something that I always try to avoid.