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Simple tube phono stage

ÿÿÿÿ CRYSTAL START-2

Foreword

Quite a lot of time has passed since the publication of the “Start” scheme, the scheme has been repeated many times by different people, and a small amount of statistics has accumulated based on comments and wishes. And to some extent, I myself have become a little wiser, and my outlook on some things has changed. Actually, the basic approach has not changed, but the priority of tasks in the design has already become a little different.

If we return to the corrector, then the least complaints were about the sound quality, and significantly more questions were caused by its repetition (despite the fact that the scheme is extremely simple). “Start” turned out to be a thing in itself - the 6F12P lamp has no even approximate analogues, a lumped correction circuit requires the use of specific capacitance ratings or a complete recalculation, and certain the problem was over-amplification. For MC cartridges, this was not enough, but for MM it was a lot, which complicates the insertion of the corrector into the tract. Naturally, I tried to upgrade "Start" and do its more "friendly" for repetition. It was possible to realize part of the plan, but it was not possible to reduce the excess amplification in simple ways and without harming the sound. Finally, the schema became completely different.

Corrector circuit

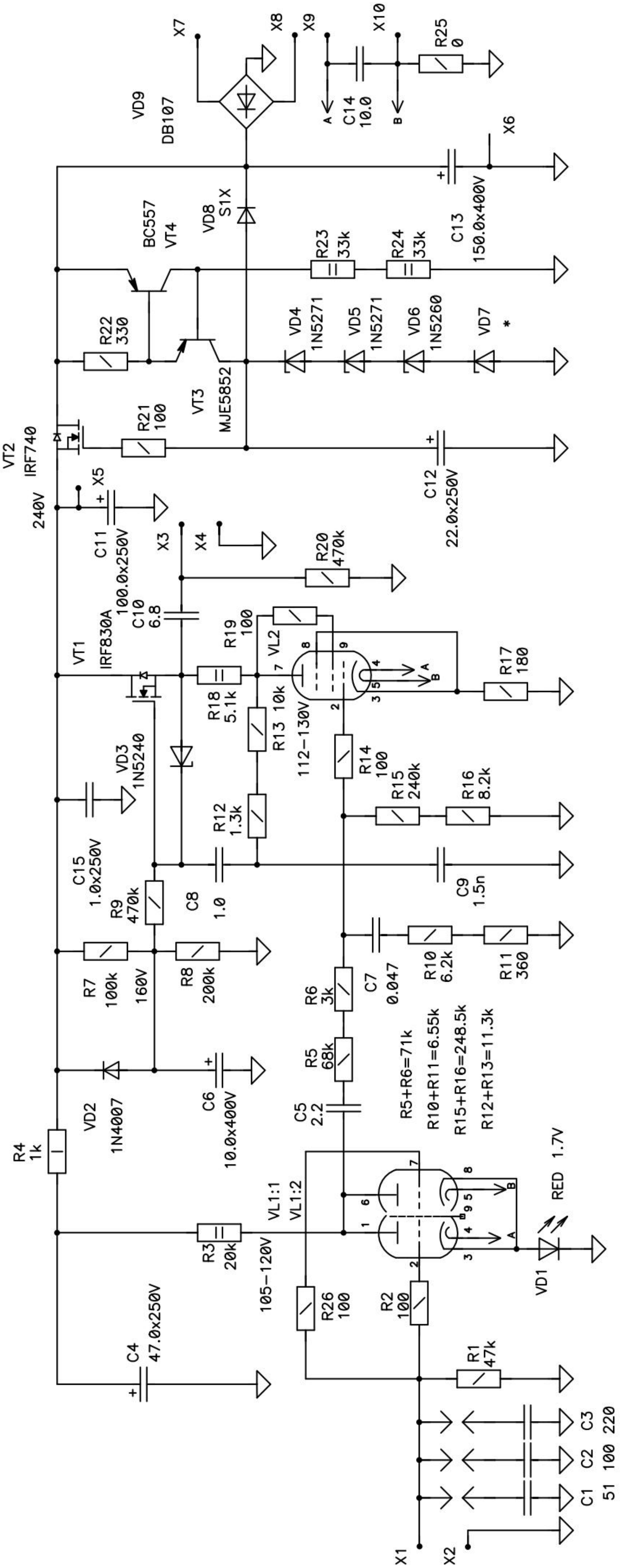
The corrector circuit is shown in Figure 1. The ideology has not changed significantly - the corrector is two cascade. But now separate lamps are used for the input and output stages. This facilitates the selection of lamps in pairs, and makes it possible to use other types of lamps with similar parameters. ramie.

The first stage is implemented according to the classical scheme with a common cathode and a fixed bias. The lamp offset sets the voltage drop across the VD1 LED. You can return if you wish. and to battery bias with a slight anode resistor value correction. Since the lamp 6N1P is not at all a record holder in terms of noise level, then to partially compensate for this fact, both triodes lamps are connected in parallel. For the convenience of adjusting the input capacitance of the corrector immediately at the input a set of capacities switched by jumpers is installed. Instead of a 6N1P lamp, you can use 6N23P and its imported analogues.

The correcting chain that forms the desired frequency response of the corrector is now divided into two parts. The first stage is loaded on the corrective circuit R5, R6, R10, R11, C7, which sets the constants time 3180µS and 318µS. The second correcting chain R12, R13, C9, which sets the time constant of 75µS, is integrated into the output stage.

In a sense, the decision is controversial, since it reduces the overload capacity of the corrector. But taking into account the high overload capacity of the base amplifier (about 26dB) and the dependence of the EMF of the cartridge on the vibrational speed, this does not lead to a noticeable deterioration in the quality sound. At a frequency of 1kHz, the corrector already has an overload capacity of 40dB, which is quite enough.

But splitting the correction circuit has several important advantages. Since corrective Since the circuits are decoupled, there is some freedom both in the choice of their parameters in terms of optimizing the load on the excitation stage and in the choice of ratings. In this case, the denominations of containers from the widely used series E6 are used, which greatly facilitates their selection and “extraction”. Another important advantage of this circuit design is the absence of amplification voltage after the second corrective chain. This is very good for noise. output characteristics of the corrector.



X7
X8
X9
X10
VD9
DB107
C14
10.0
R25
0
X6
BC557
VT4
VD8
S1X
R23
33k
R24
33k
C13
150.0x400V
R22
330
VD4
1N5271
VD5
1N5271
VD6
1N5260
VD7
*
VT2
IRF740
R21
100
VT3
MJE5852
C12
22.0x250V
240V
X5
C11
100.0x250V
X3
X4
R20
470k
VT1
IRF830A
C10
6.8
R19
100
VL2
R17
180
R18
5.1k
R13 10k
112–130V
VD3
1N5240
R14
100
R15
240k
R16
8.2k
R12
1.3k
C15
1.0x250V
R9
470k
C8
1.0
C9
1.5n
R7
100k
160V
R8
200k
R6
3k
C7
0.047
R10
6.2k
R11
360
R4
1k
VD2
1N4007
C6
10.0x400V
R5
68k
C5
2.2
R5+R6=71k
R10+R11=6.55k
R15+R16=248.5k
R12+R13=11.3k
VL1:1
VL1:2
RED 1.7V
R3
20k
105–120V
VD1
C4
47.0x250V
R26
100
R2
100
R1
47k
C3
220
C2
100
C1
51
X1
X2

Рисунок 1

The output stage is implemented as a hybrid SRPP stage. Lamp 6ZH9P is included in the triode mode and was chosen due to the wide opening of the anode characteristics and low noise level, it works lamp with automatic displacement (R17). Since in such a cascade the value of the cathode resistor is small affects the gain, this made it possible to obtain the desired lamp mode and do without shunt capacitance. The mode of operation of the transistor VT1 for direct current sets the divider on resistors R7, R7. Diode VD2 and zener diode VD3 are protective. The use of a hybrid circuit is optional, but can reduce voltage

power supply without degrading the overload capacity and obtain a sufficiently low output impedance (within a few ohms). This noticeably weakens the requirements for the parameters of the interconnect cable. To the fighters for the purity of the tube rows, I want to say right away that there is no profit in terms of sound from replacing they will not receive a transistor for a lamp. But they will receive inner satisfaction, the need for increased supply voltage and increased output impedance.

An anode voltage stabilizer with a rectifier and a filter capacitance was immediately integrated into the corrector circuit. The stabilizer is assembled according to the simplest parametric scheme. The output voltage is set by a chain of zener diodes VD4-VD7 in the gate of the pass transistor VT2, which are powered by a current source (about 2mA) on transistors VT3, VT4. Capacitance C12 shunts the inherent noise of the zener diodes and provides a smooth increase in the anode voltage. If a choose the value of this capacitance more, then there will be a delay in the supply of anode voltage. Despite simplicity, the circuit has an excellent frequency response, low noise level and a fairly high ripple suppression factor (about 500). The minimum voltage margin at the input of the stabilizer (including ripples) is 10 volts. The use of a stabilizer, in addition to obvious advantages: increasing the stability of the corrector when the mains voltage changes and reducing crosstalk, has a side effect.

positive effect. A stable anode voltage (240 volts was specially chosen) allows the use of capacitors for a standard voltage of 250 volts without a margin, which is essential. significantly reduces their cost and expands the range of their types. The glow of the lamps is powered by a rectified, unstabilized voltage. Permissible level of ripple voltage filament - 30-50mV. Of course, the ideal option would be to use an LDO stabilizer (stabilizers).

Torah.

If you implement the corrector exactly according to the above scheme, then you will get a device with a coefficient transmission rate of about 40dB at 1 kHz (slightly varies from the parameters used lamps), with a harmonic coefficient at an output voltage of 1V of the order of 0.005% with a single second harmonic and a frequency response deviation from the specified one, not exceeding 0.4÷0.5dB. Consumption current one channel corrector about 14mA

Construction and details.

It should be borne in mind that everything that will be said below is purely advisory in nature.

PCB mounting and/or routing requirements are standard for high gain devices. The power propagates towards the signal, the variable component of the signal current in the cascade should be closed within the cascade along the contour of the minimum length, it is not worth making the wiring of the common wire as a star. I would certainly recommend a PCB rather than hinged mounting, which ensures the identity of the channels in parasitic parameters (and errors ÿ).

In any case, we must strive to make the installation or board as compact as possible. The test sample was implemented according to these principles (Figure 2). Structurally, it turned out to be more convenient for me to implement each channel on a separate board, it turned out to be more convenient for optimal routing. There is no need to look for some hidden meaning in this decision, just the box that I liked, in that case, required minimal alterations. It should also be taken into account that lamp correctors are very sensitive to external pickups (you should immediately forget about all sorts of wooden boxes), if lamps are placed outside the shielding case, it is highly desirable to put on shielding caps on them. If the corrector is implemented on a printed circuit board, then it is necessary to exclude a rigid mechanical connection between the board and the case in order to reduce the microphone effect.

Transistors VT1, VT3 do not require coolers, transistor VT2 must be installed on a radiator with an area of 3-4 cm2 .

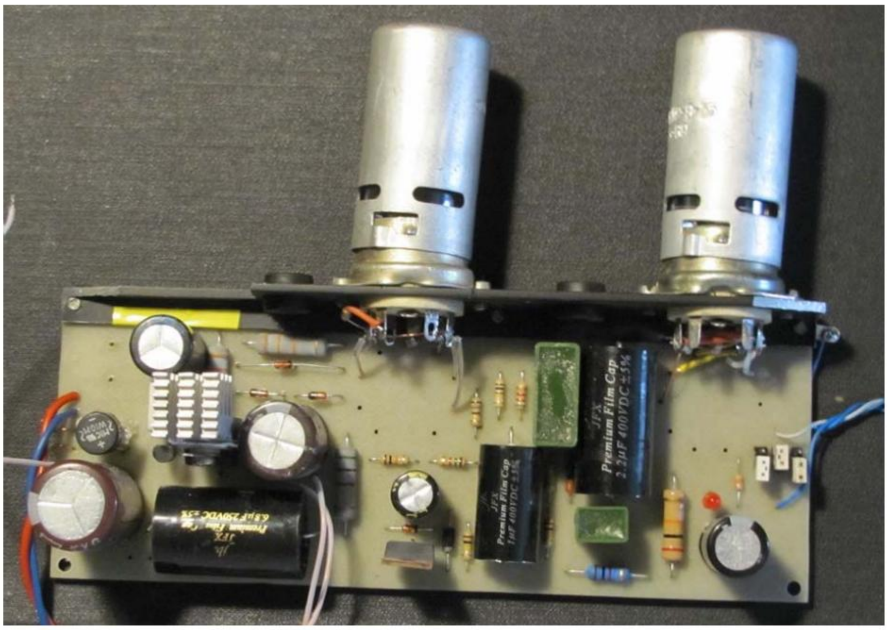


Figure 2

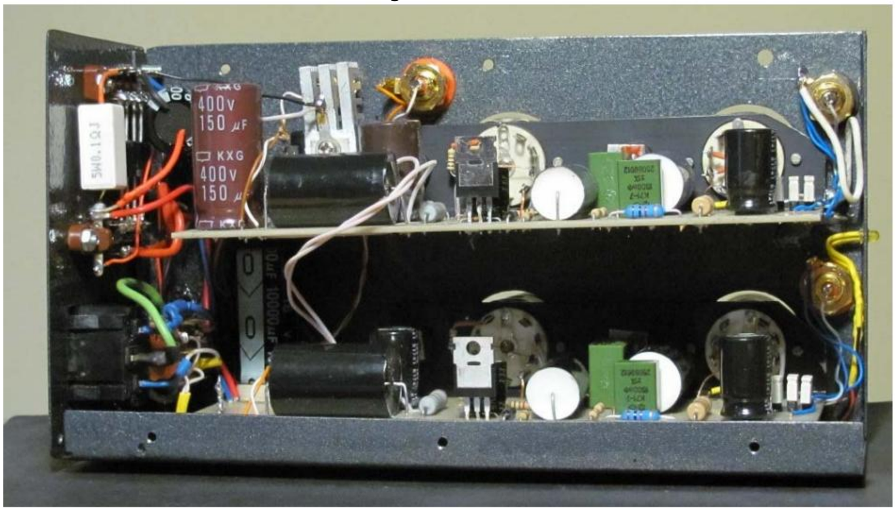


Figure 3

And this is what the assembled corrector looks like with the cover removed

When choosing components, I proceeded from the principle of reasonable sufficiency, minimizing cost and availability. If desired, the cost of a complete set can be inflated to incredible values, I don’t see (and don’t hear) any particular expediency in this.

The circuit uses carbon resistors manufactured by Royal Ohms cfr series, which have good linearity and low self-noise. Electrolytic production tanks
Nichicon UCA or PW series. A cheaper but not worse alternative is the SAMWHA RD or SD series. Capacitances in the signal circuit (C5, C8, C10) of the JFX series manufactured by JB. Capacities are listed as specialized for audio. As practice has shown, when using them as separators with a large polarization voltage, in terms of sound quality they are not inferior to the capacities of more eminent manufacturers at a cost lower by 3÷4 times. A good alternative would be to use WIMA tanks of the MKP4, MKP10, FKP1 series. Filament voltage filter capacitances - any manufacturer. Capacitors that set the input capacitance of the corrector (C1÷C3) can be used ceramic with characteristic NP0 and an accuracy of

±5%

accuracy - not worse than 1%. Of course, the main problem will be the exact capacitances. The best option is to find capacitors of the K71-7 type of the required rating, if there is something to measure the capacitance with sufficient accuracy, then, as practice has shown, out of a dozen capacitors with an accuracy of 5%, it is quite possible to choose a pair with the desired rating and permissible error. Other types of capacitors with polystyrene and polypropylene dielectric with minimal parasitic parameters are quite suitable. In extreme cases, you can choose a pair of containers with a denomination close to what you need, and recalculate the resistor values.

With resistors, everything is much simpler, since quite a few models of multimeters have an error in measuring resistances within 0.3÷0.5%. The best option is to take a precision resistor of the nearest (lower) value of higher resistance in a pair and match it to
add 5% resistors to it to get the required total resistance. Nothing particularly bad will happen if you just choose pairs of resistors with a 5% deviation. The maximum that this threatens is insignificant deviations in the frequency response when the temperature changes. Although in advertising materials they like to indicate deviations from the RIAA characteristic in fractions of a decibel, in real life, in order to fix a deviation of 1 decibel by ear, one must be Great
with my ear.

And a few words about the power system. High voltage rectifier with stabilizer shown in figure 1. Its output voltage is determined by a chain of zener diodes VD4÷VD7, in order to obtain a voltage of 240 volts at the output, the voltage on the chain must be of the order of 243÷244 volts. Since zener diodes have a rather large spread in stabilization voltage, the required voltage is obtained by selecting zener diodes (operating current is about 2mA), and it is advisable to do this before final installation in the circuit. The combination of stabilization voltages can be any. I have
I got the right voltage when using three 75 volt zener diodes. And a small remark regarding the transistor VT3. There is no such powerful transistor to use there no need (this turned out to be at hand), but it should be noted that when starting the circuit (especially with a large value of capacitance C12), the entire voltage of the rectifier is applied to it, and the peak power dissipation can reach 0.6÷0.8 watts. The transistor must withstand for a short time such power. In principle, any pnp transistor with a permissible voltage of at least 400 volts and a dissipation power of more than 1 watt will do. The filament rectifier is assembled in a bridge circuit (a circuit with a midpoint is preferable) on Schottky diodes (5 amperes) and loaded on an RC filter. Resistor resistance of the order of 0.3-
0.8 Ohm (to be specified during commissioning), total filter capacitance - 20000µF.

I will not give winding data of a power transformer, the manufacture of a single copy on the “knees” is both very troublesome and does not guarantee a good result. Much easier choose a ready-made transformer from the TAN series or simply order according to the data below. The nominal mains voltage is 220 or 230 volts, at your discretion. Anode winding - voltage 225÷230 volts at a current of 70mArms.

The filament winding is a voltage of 6.3 volts at a current of 3Arms. The voltages on the windings are indicated at the rated mains voltage. It is highly desirable to have screen transformer, and if the transformer is custom-made, then reduced induction.

As a result, we got such a device (Figure 4) in the style of studio equipment of the 50s ÷ 60s years without any "architectural" excesses and glamor.

Figure 4

Beautiful or not beautiful - it's hard to say, but there is some charm in appearance, look at the correction tor does not cause rejection and irritation.

Adjustment

If the corrector is assembled without errors and serviceable components are used, then, as such, adjustment is not required. It would be more correct to say: verification.

It is advisable to turn on the corrector for the first time with a smooth increase in the network voltage to the nominal value using a laboratory autotransformer. First of all check the supply voltage, if the zener diodes were not selected in advance, then it is necessary to set the anode voltage to 235 ÷ 242 volts and clarify the resistor value in the filament voltage filter. It is advisable to immediately install this resistor with a deliberately large value (about 1 ohm) and then reduce it to the required value in order to obtain a heating voltage of 6.3 ± 0.1 volts.

Then you should check the voltage on the capacitor C6 (a deviation of ± 5 volts is permissible) and at the lamp anodes. If the voltage at the anode is very different from that indicated in the diagram, then most likely this lamp will not work or is faulty. All d.c. measurements are made with a short circuit. equal input of the corrector. If

there are no complaints about the modes, it is necessary to evaluate the level of background and noise at the output of the channels (it is desirable to have an oscilloscope, but you can do it by ear). Noise level in the medium frequency region the corrector is quite small (50÷100 microvolts), the level of very low frequency shot noise (a few hertz) depends on the quality of the lamps, but the background level depends very much on the correct wiring and connection points of the common wire to the chassis and other elements. It is possible that you have to "conjure" with the connection points. In the test sample, as a result of stubborn sorcery, the background voltage swing at the output does not exceed 800 microvolts, which can be considered quite satisfactory. If you have an oscilloscope, you should also check the absence of self-excitation, which may occur for some batches of lamps (a surprising fact - but a fact).

The next step is to check the channel gain. To do this, a signal of 1 kHz 5÷20mV is applied to the input of both channels and the output level is controlled, a spread of 5÷10 percent is quite acceptable, it is impossible to register this by ear. If necessary, you need to pick up lamps, this is the other side of the coin of the lack of general feedback. As a rule, the presence of 3-4 lamps of each type allows you to equalize the transmission coefficients of the channels without any problems. The final chord may or may not be a check of the frequency response of the

corrector for compliance with the RIAA curve. Why it may not be - because it requires the presence of already sufficiently accurate equipment, which not everyone has.

After completing all these procedures, you can begin the main test - subjective. What I want to note is that untied chains of correction untie the designer's hands. Basically, you can adjust the frequency response of the corrector for a specific sound path. From a technical point of view, this is of course not correct. But given that the corrector is not manufactured to measure the frequency response, then this way quite possible. There is such a possibility, and it is up to you to decide whether to do it or not.

Conclusion

In this project, I tried to keep all the best that is in tube correctors (short path, high overload capacity, good linearity without the use of a common feedback circuit).
connections), and at the same time make the scheme more convenient for repetition and modification. Not unimportant factor was the requirement of the budget of the basic version. But you should not be misled by the word "simple" in the title, the circuit is really simple, but its repetition requires a little experience in the design and adjustment of tube devices and work with high voltages.

Concerning a subjective estimation conclusions such. The sound is better than many built-in equalizers and much better than Chinese boxes for $20÷30. When compared with top models, here he might be losing. There is no catastrophic difference - everything is smooth and correct, but dry sound. You can fully appreciate the difference if you put two devices side by side. In general, a subjective assessment is not a grateful thing, and you can put your own assessment only by listening to corrector in your system.

