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# Research and Design The Suitable Power Amplifier for Application in The Area of Sound Selection and Enjoyment

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***Abstract***

*In this paper, the authors present a research solution to design and assemble electron tube systems and other semiconductor electronic components to build up an amplifier for use in the field of high-quality sound. It also applies to signal amplification field systems for engineering industries such as aircraft control, signal transceiver systems, communication systems, and target tracking systems. Mobility, etc., to improve signal quality at a power amplifier output. Since then, that study proposed a high-quality amplifier signal control circuit for use in enjoying the sound to produce large events that need good sound. Research and experiment results with the electron tube show that the signal control system always works well, ensuring quality standards for sound and signals IEC 60268-3, IEC 60268-11.*

**Keywords:** *Lamp power electron tube, signal, power amplifier, signal amplifier.*

## INTRODUCTION

Today, when human life develops strongly, the industrial revolution 4.0 has also spread worldwide. Thanks to the application of semiconductors' properties, most of these vacuum electronics are replaced by other much smaller and cheaper electronic components. However, when enjoying the sound, the new components do not clearly show the sound's nature and quality in the music tracks. In Vietnam, the trend of many people wishing to use electron tube amplifiers brings the selection and enjoyment of sound uniquely, giving benefits when listening to good music and creating love, passion for music. [1] - [4], [7, 8, 14].

The problem of researching and designing a suitable power amplifier for use in selecting and enjoying sound with high sound quality is an issue that many people are concerned about. By studying and calculating, choosing to design an amplification system using electron tubes, the authors have studied for many years to have a high-quality amplifier to help choose and listen to the music or, in the world, the music in Vietnam. From the studies in a number of documents [2, 3, 4, 9] with the only study of conventional amplifiers, amplifiers using electron tube do not but have not taken into account the problems of sound quality in output, which does not bring inspiration for listening to music, or the enjoyment of high-quality sound in places such as crowded halls, meeting places, event venues, own meeting places coatings, concerts, etc. Therefore, the authors have researched to calculate and design a suitable power amplifier for the application in selecting and enjoying high-quality sound in civil applications use and data transmission.

The research of authors using new chips, DSP is used nowadays extensively in music and audio technology. Moreover, to simulate and calculate the control circuits that bring high results in the design process. The goal is to approach the desirable sound of analog equipment, such as music synthesizers and reproduction systems, yet with digital computation advantages. Such virtual analog modeling seems straightforward but is found demanding due to nonlinearities and parametric variation in the analog domain. For example, tube amplifiers are preferred by many professional electric guitar players due to perceptually favorable distortion, producing a rich and warm sound. The real-time modeling of analog amplifiers accurately using DSP is a surprisingly demanding task, resulting in good sound [3, 5, 13].

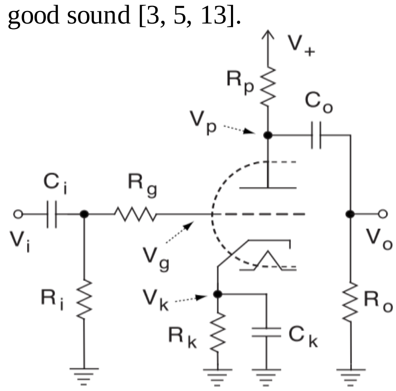


**Fig 1: The typical amplification stage when using an electron tube**

Analog circuit design is different from the development of DSP algorithms. Particularly in passive circuits, the components interact in a bidirectional way with the neighboring components through the interconnection topology. Such circuitries' transfer properties can be approximated by DSP algorithms, for example, by time-varying digital filters and memoryless nonlinearities. However, it would be desirable to design a DSP-based simulator similar to the analog circuitry by connecting component blocks via terminals and ports.

In this paper, the authors study and design an electron tube's applicability, typical in professional guitar amplifiers, application in sound selection and enjoyment, generating nonlinear behavior for distortion effects. As a case study, we take an electron tube amplifier, as shown by a schematic diagram in Figure 1. In section 2, the circuit is describedbriefly, and the modeling of electron tube characteristics is presented. Section 3 authors introduce fundamentals of wave digital filters, particularly for implementing nonlinear elements, and derive different ways to realize electron tube stages as electronic circuits [3, 15].

## II. THE ELECTRON TUBE AND AMPLIFIER STAGE

### *A. Structure of the amplifier floors*

Figure 1 is a basic amplification layer of an electron tube amplifier with the power resistor element's participation, the capacitor's input and output side, and the electron tube. These are qualitative electronic components. High-quality products are produced from countries such as Germany, America, France, Great Britain, Russia, etc.

The amplifier circuit is used in most electronic devices, such as audio amplifying circuits in Cassete, Amplifiers, Video signal amplifiers in color TVs, etc ... more We put a signal with a weak power in, the output we get a signal with a much stronger capacity. The power amplifier circuit is a combination of both voltage and current amplifier one. An amplifier system could be one floor, two amplifiers, three amplifiers, and more.

The basic applications of electron tube are amplification, wave generation, inverter, wave current, signaling indicator, television, measurement, automatic, etc., used in the field of electronics and electrical engineering telecommunications, surveillance, used in target catching radar systems, used in military, defense and security, [3, 10, 12].

### *B. The calculate the internal parameters for the amplifier*

Figure 1 depicts the schematic diagram of an amplifier stage used in audio amplifiers. Input signal Vi is passed through DC voltage separation high - pass of $C_i$ and $R_i$. Then it is fed to the grid of the electron tube. The resistor $R_g$ may be used to limit grid current for positive grid - to - cathode voltages $V_{gk} = V_g - V_k$ and avoid instabilities. The cathode resistor Rk is used to make a desired negative bias for $V_{gk}$, and the capacitor Ck makes a bypass for Rk at audio frequencies. The plate circuit of the triode consists of Rp of the plate resistor feeding the supply voltage V+. The plate voltage $V_p$ is taken to output $V_0$ through $C_0$ and $R_0$ to separate Vp's DC component. The plate current through the triode depends on $V_{gk}$ and $V_{pk}$, the plate - to - cathode voltage. The tube works as a nonlinear voltage-controlled resistor. For an idealized electron tube, the plate current $I_p$ depends on the plate - to - cathode voltage $V_{pk}$ and grid - to - cathode voltage $V_{gk}$ according to [11, 12, 13, 15].

$$I_p = f(V_{gk}, V_{pk}) = K(\mu V_{gk} + V_{pk})^{3/2} \qquad (1)$$

where $\mu$ is the triode's voltage gain for constant plate current and K is another tube-specific constant. This model is not accurate enough for our purposes, however. It is possible to fit more accurate formulas to measured tube data, and we have adopted an experimentally well-fitted model given in [7, 11].

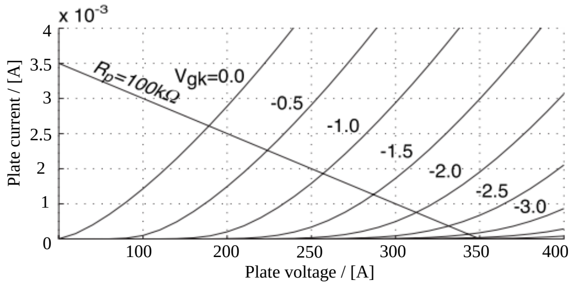


**Fig 2: The characteristics of 6SN7 electron tube**

Then we have:

$$I_p = \frac{E_1^{kx}}{k_{g1}}(1 + sign(E_1)) \qquad (2)$$

$$E_1 = \frac{V_{pk}}{k_p}\log(1 + exp(k_p(\frac{1}{\mu} + V_{gk} / \sqrt{k_{vb} + V_{pk}^2}))) \qquad (3)$$

In the expression (2) and (3) and electron tube parameter values given in the text. $V_{gk}$ is the grid-to cathode voltage, and a load line for $R_p$ and $V_+$, $k_x$, $k_{g1}$, $k_p$, $k_{vp}$ are other tube-specific constants. For the electron tube, a typical preamplifier tube, the parameter values are [11].

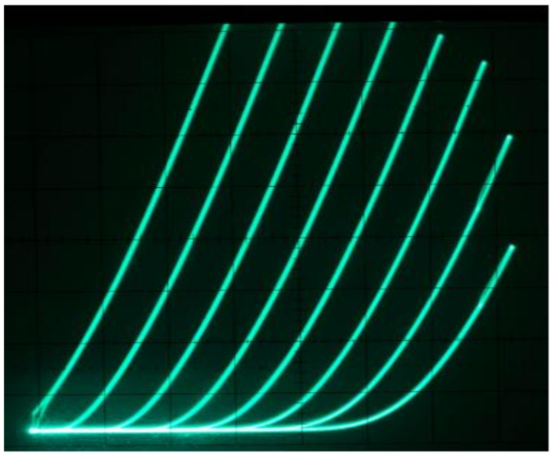

**Fig 3: The characteristics of 6SN7 electron tube reality**

Based on the new technology measuring equipment, the authors have measured the electron tube's actual waveform in real-time. This problem has made it clear that the theory of the reality of the structure of the electron tube to the reality is not very different.

This work helps the research and design, and manufacture of amplifiers using electronic components and an electron tube, providing the best sound quality for listeners. Also applied in signal amplification systems of electronics and telecommunications equipment, information electronics, and communications.

## III. THE RESEARCH APPLICATION OF SELF-MADE AMPLIFIERS IN PRACTICE

### *A. The research on the design and construction of control circuits*

Considering the system, as shown in Fig. 1 with integrated energy storage flywheel, the block diagram of the energy storage flywheel system is shown in Figure 2.

To research the design of an amplifier using an electron tube, we understand that this is an acoustic device used to amplify electrical signals and the emitted sound signals. When we design and control to put the original signal into the amplifier, the amplifier will amplify that signal and transmit it to an external audio transmitter like a speaker. We will feel that the sound quality is good or humans perceive the sound. For this purpose, the authors conduct research and design and propose a control circuit structure, a signal amplification circuit using an electron tube, as shown in Figure 4.

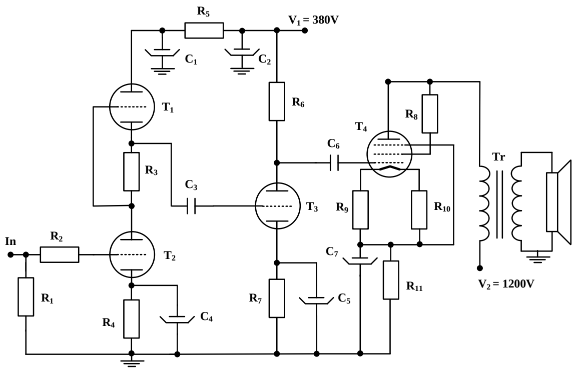


**Fig 4: The Amplifier structure diagram using electron tube study and propose**

In figure 4 include the values of the components in turn with the following parameters: $R_1$ = 330Ω/0,25W; $R_2$ = 1MΩ/ 0,25W; $R_3$ = 1KΩ/ 1W; $R_4$ = 1KΩ/ 1W; $R_5$ = 39KΩ/2W; $R_6$ = 6,7KΩ/ 6W; $R_7$ = 2,2KΩ/ 2W; $R_8$ = 100Ω/ 1W; $R_9$ = 50Ω/ 10W; $R_{10}$ = 50Ω/ 10W; $R_{11}$ = 1,1KΩ/ 30W; $C_1$ = 22µF/ 500V; $C_2$ = 50µF/ 500V; $C_3$ = 0,1µF/ 600V; $C_4$ = 220µF/ 16V; $C_5$ = 50µF/ 50V; $C_6$ = 0,22µF/ 600V; $C_7$ = 220µF/ 160V; Tr is transformer, $T_1$ is 6SN7, $T_2$ = 6SN7/2, $T_3$ is 6V6, $T_4$ is SV813.

The working principle of this circuit is basically when the circuit parameters are given as above, we proceed to supply a positive signal to the grid of $T_1$, and $T_2$ lights, the signal of $T_2$ light will lead strongly and cause the voltage drop across the cathode impedance of the upper lamp will increase so that the grid of the upper lamp will be negative, resulting in the signal light of the $T_1$ lamp reducing the led. In contrast, when the lamp's negative signal was applied to the grid of the $T_2$ lamp, then the $T_2$ lamp decreased, the voltage drop on the cathode impedance of the $T_1$ lamp decreased, leading to the lamp on the rise, which is why. The star in its name is (push-pull). This circuit outputs the cathode signal of the $T_1$ lamp, resulting in low impedance on the output side. For the signal output circuit at the Anode of the $T_2$ lamp, this time, the $T_1$ lamp acts as a load resistor for the $T_2$ lamp (active load). This circuit has a high output impedance; that's why this is considered a complete circuit, then we need to have a cathode follower behind to lower the impedance. This circuit can be considered a single end circuit. At this time, the control signal will be pumped to $C_3$, making the $T_3$ light conductive. When the $T_3$ lamp leads, the $T_4$ will lead, and the transformer output signal is active. At this time, there will be the output signal of the speaker. There is also a great contribution of the capacitor components used to filter noise and lead the signals into the electron tube lamps, making the output's signal quality have good results.

After studying and calculating the circuit diagram using electron tubes $T_1$, $T_2$, $T_3$, $T_4$, as shown in Figure 4, the authors assembled, calibrated the circuit, and tested to check the correctness of the negative equipment this recommended bar.

### *B. The realistic to experience sound quality from modern sets of eechs*

It is effectively a small push-pull power amplifier: an amazingly simple push-pull power amplifier that comprises its internal phase splitter, despite holding only two electron tubes and two cathode resistors. This last sentence is not quite accurate, as a vital but unnamed part exists - the load impedance, which is an essential part of the push-pull circuit. The load impedance is a critical part of the optimal electron tube functioning, so the electron tube is extremely loaded sensitive. In other words, for any given pair of electron tubes and cathode and current-sense resistors in the electron tube topology, there is an optimal load impedance, which allows for the best balance of anti-phase current swings between electron tubes and which delivers the lowest distortion and peak output power.

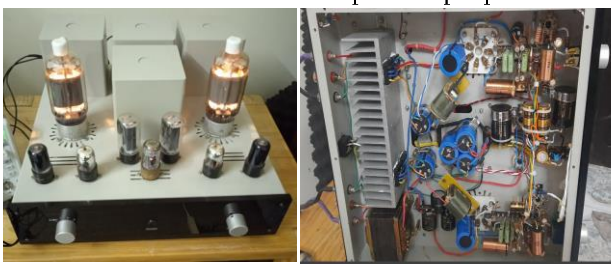

**Fig 5: The outside image and the internal structure of the amplifier using an electron tube**

Let's move on to a review of the hardworking electron tube operation. The bottom triode's cathode resistor sets the idle current and can be left unbypassed or be bypassed by a large-valued capacitor. The current-sense resistor between the top and bottom triodes delivers the top triode's input signal. The lower the load impedance, the bigger the resulting input signal will be. The see how this works, imagine that the external load impedance is a dead short to the ground; zero ohms, in other words.

As the bottom electron tube sees an increase in grid voltage, its current conduction increases, all of which must flow through the current - sense resistor, so the voltage drop across this resistor increases, thereby decreasing the top triode's conduction, as its grid sees greater negative voltage. In turn, when the bottom triode sees a decrease in grid voltage, its current conduction also decreases. Hence, the voltage drop across the current-sense resistor decreases, thereby increasing the top triode's conduction, as its grid now sees less negative voltage. The load impedance was zero ohms so that no voltage drop can occur across it. Still, the dead short to the ground does see a varying current flow, equal to the difference between the top and bottom triode conductions: $I_{out} = I_{top} - I_{bottom}$. For example, if the idle current is 10mA and no input signal is presented to the bottom triode's grid, the load sees 0mA of current flow, as 10mA -10mA = 0 mA. If the bottom triode then sees a positive input signal and its conduction rises to 15mA, the top triode's conduction will fall to 5mA, and the zero-ohm load will experience a - 10mA current flow, as 5mA - 15mA = -10mA. A single floating power supply could replace the fixed bipolar power supply, and the single coupling capacitor could be replaced by two capacitors that would span the floating power supply. Still, the input transformer is a hassle, we must admit. The way out is to rearrange the electron tubes, so the input electron tube goes on top.

After studying, calculating, designing, and assembling a control system of an electron tube amplifier with high sound quality. The authors measured the following main results:

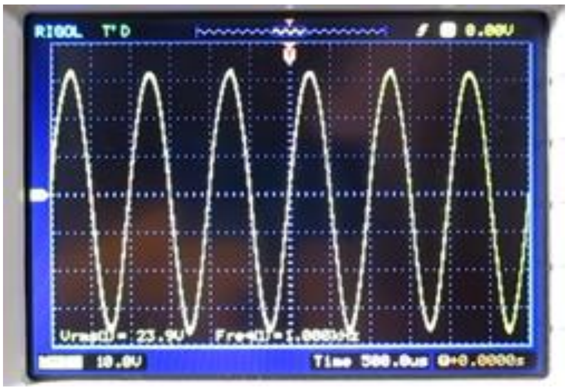


**Fig 5: The results measure and analyze the voltage signal waveform at high frequency**

In figure 5, figure 6 shows the results of measuring and analyzing signal waveforms at high frequency. During the operation of high-frequency electron tube lamps, looking at the properties, we can see that the signal quality when changing the frequency and changing the volume (sound) level is different, so the frequency and amplitude are adjusted. Changes, we see a clearer change in the waveform. These results show the correct working process of the electron tube amplifier.

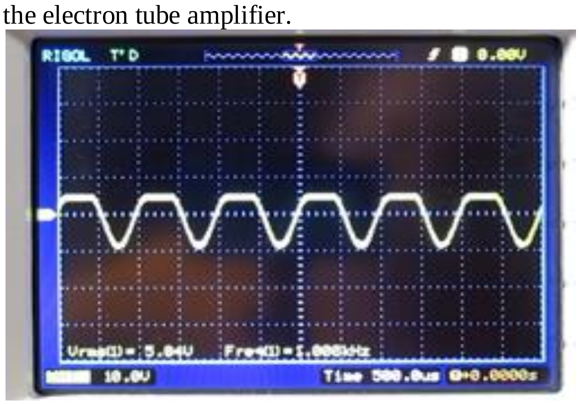


**Fig 6: The results of measurement and analysis of waveforms when the varying frequency and amplitude changes**

Spectral analysis signal as FFT when measured with the waveform shown in Figures 7 and 8, this clearly shows the efficient operation of the working power. The high sound quality when using The study proposes a control circuit using electron tube lamps.


**Fig 7: The results measured and analyzed the FFT spectrum signal waveform**

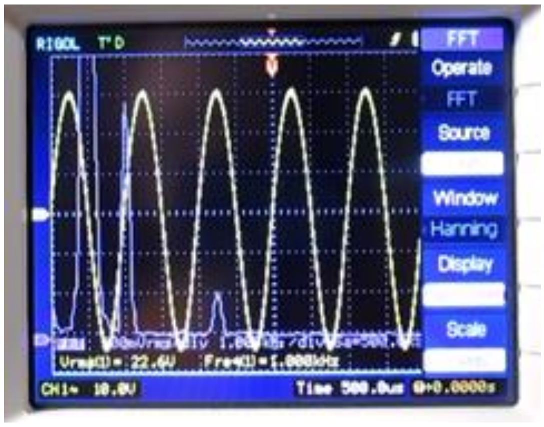


**Fig 8: The results measure and analyze the voltage signal waveform and FFT spectrum signal at high frequency**

The observing the measured results show that when using the control circuit using the electron tube which has been studied and proposed above, we see the stability; the stability of the control circuit against the effects of a nonlinear component that does not determine noise nor alter the working quality, affect the sound set output quality, increase the system's quick impact signal amplification; then the proposed control circuit is still working stably; high quality. It can be seen that the system works well; the sound quality is high for the user. Moreover, in all transient modes, the proposed control circuit's response using electron tube also gives the response time quite quickly, with high quality.

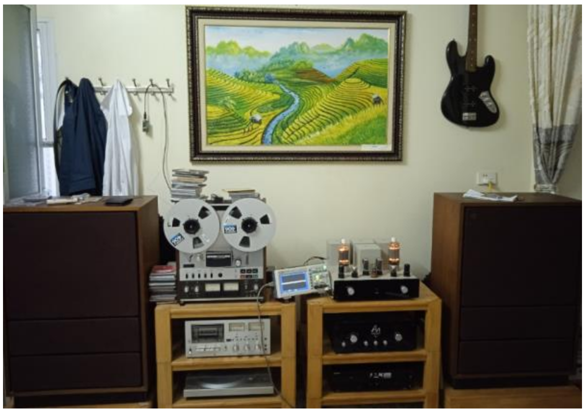

**Fig 9: Image amplifier when put into use and get high-quality sound results**

In figure 9 is a full sound system when the proposed amplifier is fully connected to the following devices: clean source system with high - performance transformer, record player, public speaker high productivity in the US, in addition to many other measuring and control equipment.

Comparing the results with studies in [10] and previous studies [12], the paper results are better than those of previous studies, sound quality, and control circuitry. The actual measured results also show these problems. In terms of the value of voltage and current, the capacity is always sufficient for both the working time and the electron tube system's quality.

## IV. CONCLUSIONS

The Enhances the quality of signal amplification (sound) used in everyday life, for relaxation beyond stressful working times, for use in music events, etc. in addition to amplification, Signals are also used in communication techniques, information gathering, in the military, mobile target -tracking radar systems, etc., always updated with new technologies with more advantages than one number of old technology before. Research results have shown the correctness and feasibility of the proposed solution. The system can be used to "smooth" and balance supply-demand signals (sounds), high-quality control signals in control systems that operate independently or connect to control devices intelligent control to bring many high economic benefits used in many different technical fields. The results given in this paper are consistent with good signal quality standards IEC 60268-3, IEC 60268-11.

## ACKNOWLEDGMENT

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