A Three-Channel Tone-Control Amplifier

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Presenting a tone-control arrangement wherein steeper low- and high-boost curves are provided without appreciable interference throughout the mid-range frequencies.

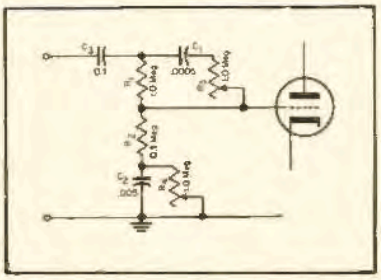

Fig. 1. Simple tone-control circuit commonly used to provide boost of both low and high frequencies.

THE TONE CONTROL to be described here may be considered somewhat elaborate, but it does produce results which cannot be duplicated by any of the more conventional circuits. It is the final result of extended experimentation to obtain the desired effect in the simplest possible manner.

Most tone control circuits use some type of R-C network to attenuate or boost either or both ends of the audio frequency spectrum. However, the problem in audio equipment is generally a deficiency rather than an excess of lows and highs. Two of the responsible factors are the limitations of the equipment, and the need for compensation for the Fletcher-Munson effect at low volume levels. Hence this article will deal only with the "boost" type of control.

A circuit which is representative of many of the common tone controls is shown in *Fig.* 1. Briefly, the voltage divider, consisting of the resistors R_1 and R_2, attenuates the signal applied to the grid of the amplifier tube. The capacitor C_1 shunts R_1 for the high frequencies, and the amount of shunting action is controlled by varying the resistance of the series potentiometer R_1, resulting in a variable high-frequency boost. For the bass boost, C_2 is introduced in series with the lower leg of the voltage divider by increasing the resistance of its shunt potentiometer R_4. Since C_2 has a greater impedance at the low frequencies, the effective attenuation at that end of the spectrum is reduced.

The main drawback of the tone control of *Fig.* 1 is the shallow slope of the attenuation curves. For example, in order to obtain an appreciable boost such as 20 db at the frequencies around 20 cps, frequencies well into the middle range of 500 to 1000 cps are also boosted. The result is the familiar "boomy" effect generally associated with juke boxes. Likewise, when the high-frequency boost extends into the middle range, a pronounced distortion of the original tonal balance is observed.

Fig. 2. The author's tone-control amplifier mounted on a small chassis for use with other equipment.

A more desirable characteristic may be obtained by a tone control which reinforces only the very ends of the audio range, below 100 cps and above 3000 cps. In these regions the limitations of the loudspeakers and other auxiliary equipment between the listener and original performance combine to cause a sharp drop in output.

A three-channel tone control amplifier which accomplishes the above aim is shown in *Fig.* 2, with the circuit diagrammed in *Fig.* 3. It is designed to be inserted between a tuner or phonograph preamplifier and the average audio amplifier input stage. The insertion gain is 6 db, corresponding to a voltage-gain factor of two. Thus, with both boost controls fully retarded, the middle-frequency amplifier tube section V_{1A} has a gain of 6 db, and is flat over the entire audio range.

The tube section V_{1A} serves as a preamplifier for the low- and high-fre-

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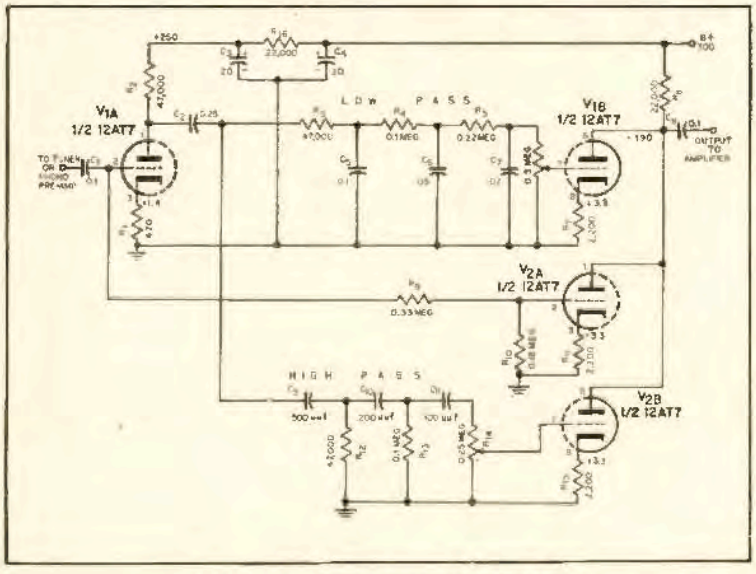

Fig. 3. Schematic of tone-control amplifier of Fig. 2.

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THREE CHANNEL

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quency channels. Its output feeds a low-pass R-C filter network in the grid circuit of V_{1A}, and a high-pass filter in the grid circuit of V_{1B}. The multiple sections of these filters produce the desired steep attenuation slope. Potentiometer R_8 controls the level of the low-frequency signals fed to V_{1B}, the low-frequency amplifier channel. Likewise, R_9 is the high-boost control feeding the high-frequency amplifier, V_{2B}. The plates of the three tube sections are tied together and are fed from a common plate resistor, thereby mixing and adding the signals from the three channels. Capacitor C_8 serves to couple the resulting output signal to the master gain control of the following audio amplifier.

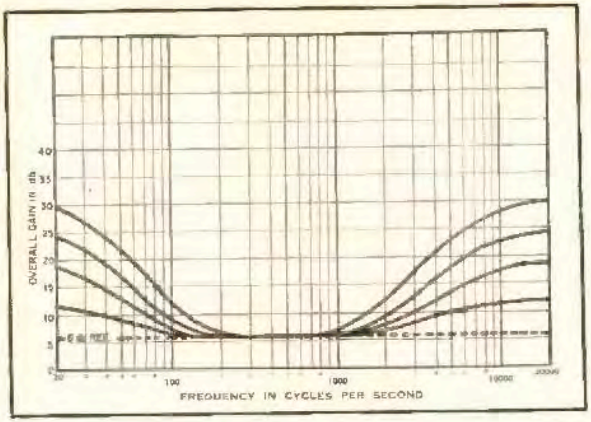

Fig. 4. Response curves obtained with three-channel tone-control amplifier of Figs. 2 and 3.

A question might be raised regarding the problem of the additional phase shift of 180 deg. in the high- and low-frequency channels, since they both have one more stage of amplification than the center channel. It is conceivable that a condition could arise wherein the low- and high-frequency components of the broad band passed by V_{1A} would cancel the signals of the other two channels. This does not occur, however, because of the additional compensating phase shift introduced by the low- and high-pass R-C filters.

The response curves of *Fig.* 4 illustrate the measured results obtained from various settings of the low- and high-boost controls. Boosts ranging from 6 db to 24 db at the 20- and 20,000-cps. spectrum extremes are shown. Note that practically no increase occurs in the middle-frequency range between 200 and 1000 cps, even at maximum settings.

Construction of the tone control amplifier is not difficult. It may be incorporated directly into an existing or proposed amplifier, or else built up as an accessory on a small subchassis similar to that used for magnetic pickup pre-amplifiers.

The author has used variations of this type of tone control for over ten years, and the results have been very satisfactory. Although it will not work miracles for a poor audio system, the degree of depth and crispness imparted to music and speech is remarkable.

Parts List

C_1, C_2, C_3	0.1 μf, 400 v. paper
C_9	0.25 μf, 400 v. paper
C_{5a}, C_{5b}	20–20 μf, 450 v. electrolytic
C_6	.05 μf, 400 v. paper
C_7	.02 μf, 400 v. paper
C_8	500 μμf, 500 v. mica
C_{10}	200 μμf, 500 v. mica
C_{11}	100 μμf, 500 v. mica
R_1	470 ohms, ½ watt
R_2	47,000 ohms, 1 watt
R_3, R_{12}	47,000 ohms, ½ watt
R_4, R_{13}	0.1 meg, ½ watt
R_5	0.22 meg, ½ watt
R_6	0.5-meg potentiometer, audio taper
R_7, R_{11}, R_{14}	2200 ohms, ½ watt
R_8, R_{10}	22,000 ohms, 1 watt
R_9	0.33 meg, ½ watt
R_{15}	0.18 meg, ½ watt
R_{16}	0.25-meg potentiometer, audio taper
V_1, V_2	12AT7 dual triodes