An Unusual Tone Control

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From time to time I have reported new developments by others, and I hope I will not be considered presumptuous if I now report one of my own.

One of the most troublesome of unresolved problems in hi-fi design is that presented by the so-called loudness control, which is meant to compensate for the fact that the frequency response of the ear varies with the intensity of the sound. At high intensity levels the response is relatively flat over the whole audible range. But as the intensity level is reduced the response falls off at both the high and low ends until, at very low levels, low bass sounds of the same intensity as the middle-frequency sounds become inaudible. Fletcher and Munson investigated this 25 years ago and prepared the well-known Fletcher-Munson curves from their data.

DIFFERENT TASTES

The Fletcher-Munson curves we see in hi-fi literature are actually abstract curves of several hundred diverse human ears. These abstract curves are extremely helpful in improving our understanding of the processes of hearing, but they are not universal curves applicable to all or even a majority of human ears—any more than the measurements of an average or mean American male are applicable to all or even a majority of American males.

And yet, too many engineers, both amateur and professional, have treated the Fletcher-Munson curves as if they could be applied universally. There might be some justification for such use in strictly communication media (such as the telephone) which do not pretend to provide faithful reproduction. But high-fidelity equip-

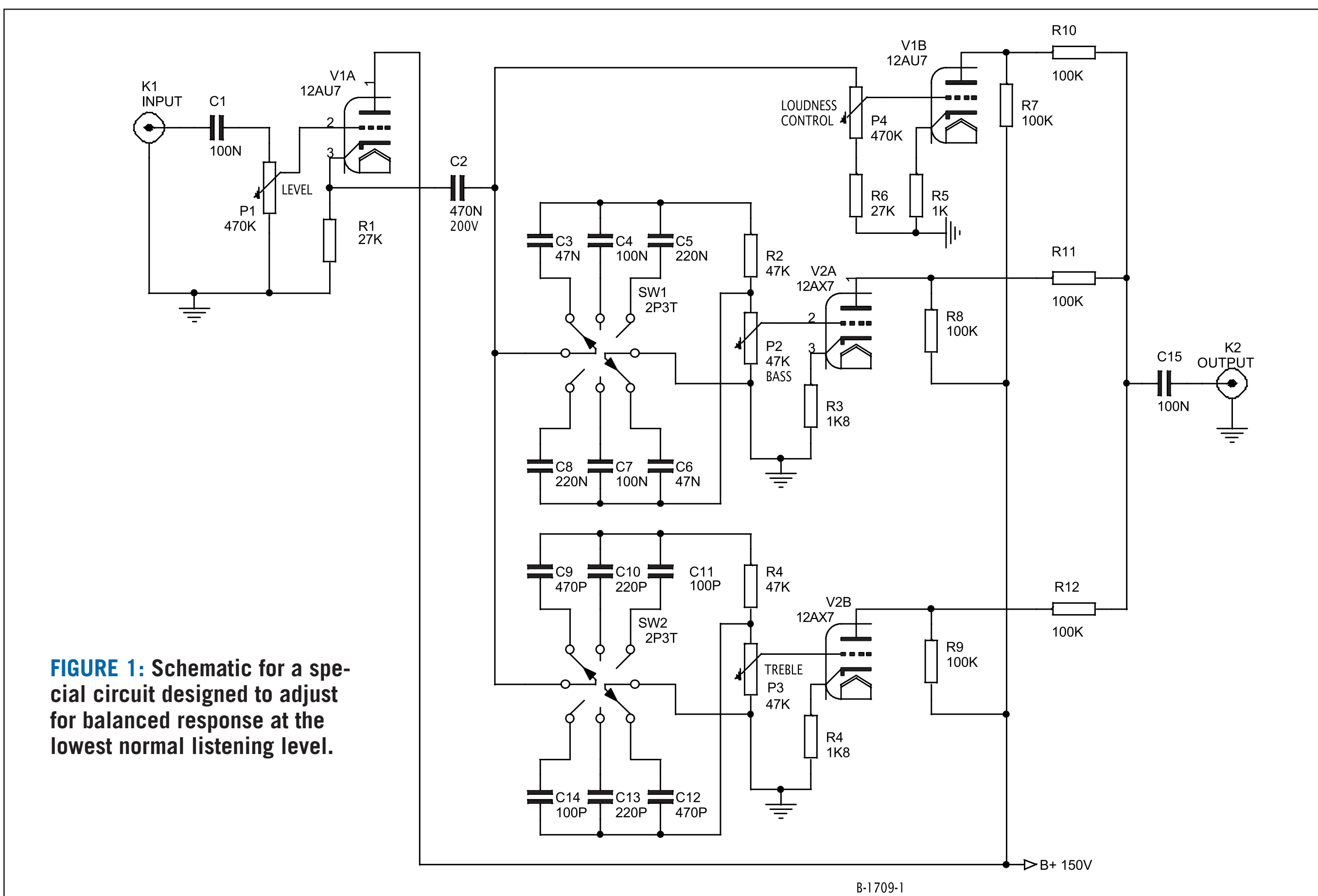

FIGURE 1: Schematic for a special circuit designed to adjust for balanced response at the lowest normal listening level.

ment is intended to furnish faithful reproduction, and a universal application of the Fletcher-Munson curves is about as likely to ensure faithful reproduction for everyone as a suit tailored to the measurements of the average American male would be likely to make every man well-dressed.

This would be true even if all listeners agreed in their preferences. But, as a matter of fact, some listeners prefer a frequency balance approximating that of an orchestra heard very close-up, while others prefer that of an orchestra rather more remote, and this difference requires different degrees of equalization as well as different sound levels.

Actually, if we look into the original Fletcher-Munson data and subsequent research efforts in this field, we will find that the one thing they make very clear is that there is a wide variation in the hearing capabilities of individual human ears. If these studies prove anything of value for high fidelity, it is that the loudness-level contours vary so much both with different ears and with different intensity levels that any equipment which hopes to provide the highest degree of faithfulness for the greatest number of people will have to include a means of varying the loudness contours pretty widely.

ADJUSTMENTS

It is significant that the original attempt to stick closely to the abstract Fletcher-Munson curves on all equipment has been a failure. Only the cheapest and simplest hi-fi equipment today offers a single loudness compensation control. In the better equipment engineers have tried to provide some range of variation.

In some instances this takes the form merely of a switch to disable the loudness control entirely; in others, the loudness control is paired with a level control and, when properly operated, the combination can furnish a sufficient variation to suit many and perhaps a majority of ears. In still others, there are contour selector switches or controls which provide a choice of slopes, as well as degrees of boost. A notably felicitous solution is found in the Marantz control unit in which a

LOUDNESS COMPENSATOR control provides some variation of both the slope and the boost, and when used in conjunction with the excellent tone controls, can meet a wide variety of requirements or preferences.

Many experts, especially in Great Britain, believe that the best way to handle the problem is by means of the tone controls. Also, many owners of American systems with loudness controls have found that they obtain the most satisfying sound by disabling the loudness control and merely adjusting the tone controls. Actually, this approach has great merit. The only trouble is that, if we desire to maintain a truly perfect balance, we must readjust the tone controls every time the volume changes substantially.

TONE-CONTROL SOLUTION

I have inclined to this point of view myself, but have been plagued with the problem of removing the disadvantage ever since I first started to fool around with high fidelity many years ago. For five years now I have been experimenting with a circuit which seems to me to come closer to a satisfactory solution than any other method I have tried. This involves providing greater versatility in shaping the response curve of the system to take care of all the factors which necessitate a modification from flat response. These factors include the hearing curves of the listener, the level at which the sound is reproduced, the nature of the listening environment, any deficiencies in the source material, and, finally, the characteristics of the reproducing system, particularly the speaker.

To achieve this I use two tone-control channels, each of which provides a choice of peaking points or slopes, and a maximum boost of between 15 and 20dB. This provides a flexibility approaching that of the equalizers used in recording and broadcasting. Among other things, it will handle the problem of loudness compensation at any given volume level very nicely, since both the slope and the amount of boost can be varied as necessary.

There remains the problem of disposing of the need for readjusting the tone compensation when the volume level is changed, and the circuit provides a means of doing this which is quite satisfactory. There are two gain or volume controls. One of these maintains the equalization as volume is increased or decreased, and the other can be called a LOUDNESS control, although it works in an opposite manner to the usual con-

PARTS LIST: ONE CHANNEL

QUANTITY	REFERENCE	PART
4	C1, C4, C7, C15	100N
1	C2	470N
2	C3, C6	47N
2	C5, C8	220N
2	C9, C12	470P
2	C10, C13	220P
2	C11, C14	100P
1	K1	INPUT
1	K2	OUTPUT
2	R1, R6	27K
2	R2, R4	47K
2	R3, R4	1K8
1	R5	1K
6	R7, R8, R9, R10, R11, R12	100K
2	SW1, SW2	2P3T
1	V1	12AU7
1	V2	12AX7
2	P2, P3	47K
2	P1, P4	470K

trol. In the conventional loudness control circuit, the system is equalized at a very loud level, and, as the volume is reduced with the loudness control, the bass and/or treble are boosted in relation to the middle frequencies.

STRIKING A BALANCE

In my circuit, the system is adjusted for a balanced or satisfying response at the *lowest* normal listening level. As the LOUDNESS control is turned to increase volume, the bass and treble boosts are progressively washed out until, at maximum volume, the response is flat. This seems to be a preferable method because the ear is not nearly so sensitive to frequency imbalance at very loud levels as it is at low levels. In any case the big problem in home listening is to compensate at low or moderate levels and this method makes possible a far more precise adjustment.

This is achieved by means of the circuit shown in *Fig. 1.* There are three parallel channels fed by the same source and tied together at the output. The uppermost channel is the flat channel, the next is the bass channel, and the bottom is the treble channel. Response of the two lower channels is shaped by networks of the Wien-bridge type. All three channels have gain controls.

It is obvious that the input to the following stage will be the sum of the outputs of all three stages. The gain control in the flat channel is the LOUDNESS control, and is normally at its minimum position, at which point the stage has no gain or a slight loss. The BASS and TREBLE channels provide a direct boost of 20dB or more. The interesting point is this: increasing the gain on the flat channel will start washing out the boost of the lower channels, and when the flat channel is at maximum the boost cannot be more than 6dB.

To provide a choice of response shapes and crossover frequencies, three switch-selected networks are used in the bass and treble channels. The values shown give excellent results, both for tone control and loudness control. Increasing the value of the capacitors moves the crossover downward.

This circuit may be incorporated as part of a control unit, replacing both the tone control and loudness circuits; it can also be used as a separate unit to precede or to follow a present control unit. The two 470k controls can be of the coaxial type to save space. The circuit provides a large versatility in adjustment.

The simplest way to initially set it is as follows: 1. Put the LOUDNESS control and the two tone controls in their minimum volume position; 2. Adjust the LEVEL control to produce the lowest normal listening level; 3. Now, with the tone controls, adjust the BASS and TREBLE for a satisfying balance and over-all sound; 4. Increase volume with the LOUDNESS control as desired. Increasing this control will progressively wash out the bass and treble boosts to compensate for the increased acuity of hearing at both ends as volume is increased. ❖

Editor's note: It might be convenient to use switched step controls for P2 and P3 so as to have resettable positions for a variety of recorded material.