An Improved Loudness Control

J. P. WENTWORTH*

While many music lovers and hi-fi enthusiasts would not be caught dead with a loudness control, there are at least as many more who wouldn't do without one. For them as likes 'em, here is a new arrangement with several advantages.

There has been much discussion of the relative merits of the loudness control, in which the signal level is varied in accordance with the Fletcher-Munson subjective loudness curves, as compared with the simple gain control, which raises or lowers the signal level an equal amount at all frequencies. It is not the author's intention to reopen the controversy at this time. The purpose of this paper is to present, for those who favor the use of a loudness control, an improved circuit that gives a good approximation to the Fletcher-Munson curves, while using less expensive or complicated components than any other such circuit the author has seen.

Continuously-variable loudness control circuits published to date usually depend on the use of either a tapped potentiometer or a special control made up of several potentiometer elements on a single shaft.[1,2,3] As a result, such controls tend to be expensive and of limited flexibility, and to present other serious disadvantages, such as an appreciable insertion loss, a variation in the impedance presented to the previous stage, a lack of mechanical strength, or the like. Furthermore, because they include several moving parts, or, in the case of the multitapped control, a rather complicated mechanical arrangement, maintenance troubles are multiplied.

The circuit shown in *Fig.* 1 includes only one moving part—an ordinary The circuit shown in *Fig.* 1 includes only one moving part—an ordinary single-section potentiometer, with no taps. All of the other components are standard low-cost resistors and capacitors. The frequency-response curves of this circuit are shown in *Fig.* 2 (solid curves). As may be seen by comparison with the dashed Fletcher-Munson curves, the output is very well matched to the response of the average human ear over a 40-db variation in sound level.

Other features of this type of circuit which compare favorably with conventional circuits are: (1) it introduces no insertion loss, and (2) the impedance it presents to the previous stage does not vary with the setting of the control.

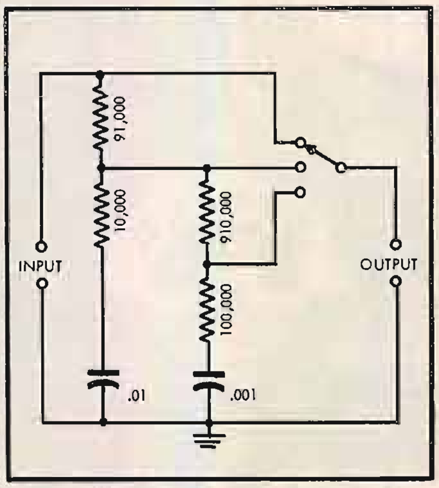

Fig. 1. Schematic diagram of the author's improved loudness control.

Because the variable element in the control is a simple potentiometer, this configuration lends itself to a flexibility of operation that is not possible to other circuits. For example, the potentiometer can be replaced by the combination of a fixed resistor and a vacuum-tube resistance element. Then, since the setting of the control can be varied by adjusting a direct voltage, the loudness-control effect can be obtained with remote control, the control can be varied by adjusting a direct voltage, the loudness-control effect can be obtained with remote control, automatic volume control, or compressor/expander operation. Various other applications might be devised by using fixed resistors in conjunction with other types of variable resistance elements, such as varistors or thermistors. Care should be taken in such applications, however, not to introduce large amounts of phase shift or distortion in the control circuit, as the shape of the over-all response curves depends greatly on the phase relationships within the circuit.

Principle of Operation

The principles of operation of the control can be more easily understood if the circuit is considered in three parts. The frequency response of the two-stage integrating (low-pass) network made up of R_1, R_2, R_3, R_4, and the two capacitors is shown in *Fig.* 3. The output of this circuit is added to the output of the potentiometer via the summing network consisting of R_5 and R_6. However, since the two summed outputs are not in phase with each other, the voltages do not add directly, but in such manner as to produce the response curves given in *Fig.* 2.

Another feature of the circuit is that it can easily be converted to a conventional gain control, merely by breaking the circuit at point "A" (*Fig.* 1). It might well be argued that such a feature is of doubtful utility, since this circuit, like all loudness controls should be operated with an auxiliary level control, which is used to set the over-all signal like all loudness controls should be operated with an auxiliary level control, which is used to set the over-all signal

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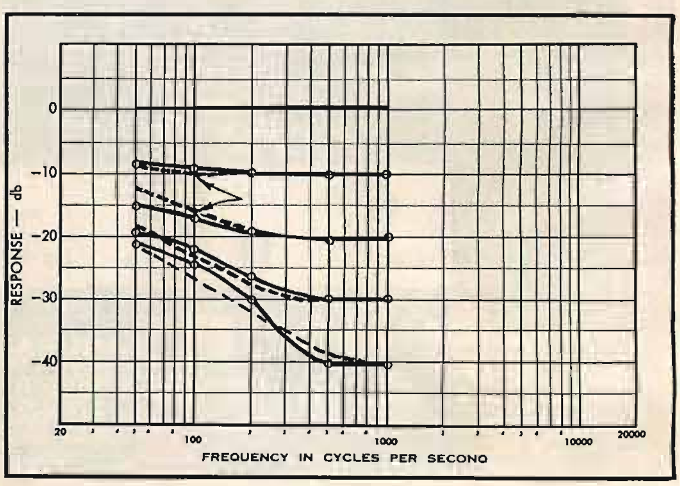

Fig. 2. Frequency response curve for the circuit shown in Fig. 1.

* *American Consulate, Medellin, Colombia*

[1] E. E. Johnson, "A continuously variable loudness control." Audio Engineering, December, 1950.

[2] Ray C. Williams, "A feedback loudness control." *Radio & Television News,* March, 1954.

[3] J. W. Turner, "Construction details of a continuously variable loudness control." Audio Engineering, October, 1949.