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TONE LEVEL CONTROL CIRCUIT

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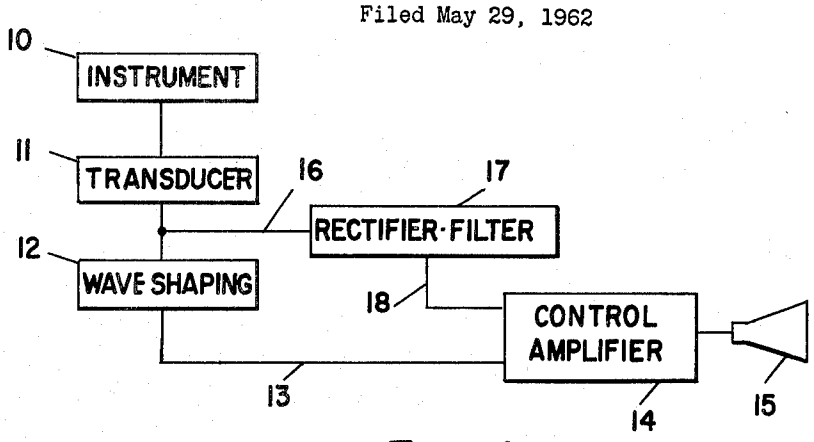


FIG. 1.

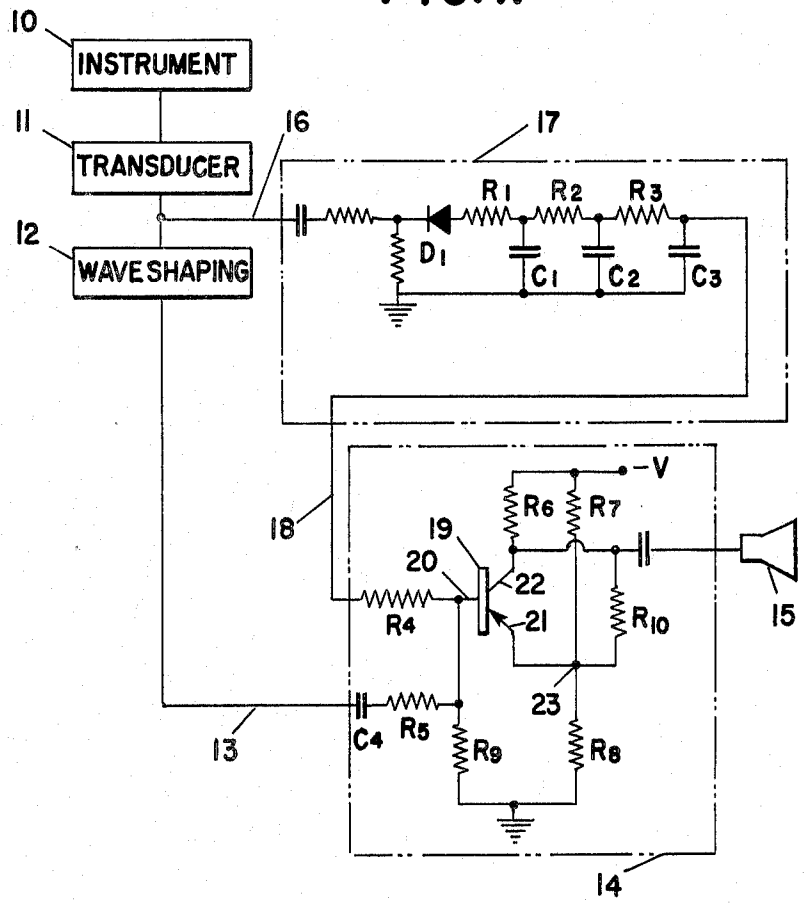


FIG. 2.

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TONE LEVEL CONTROL CIRCUIT

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1 Claim. (Cl. 84—1.27)

This invention relates generally to electrical tone generating circuits as used in musical instruments and more particularly to a novel tone level control circuit for improving the quality of output tone signals generated by electrical means in response to playing of a musical instrument.

Most electrical tone generating systems include wave shaping circuits which are triggered for operation to generate a modified A.-C. signal of a given frequency and amplitude in response to an original A.-C. signal in turn constituting the output of a tranducer. The transducer itself may be energized by a vibrating reed, string, bar, or similar physical element set in motion by the musician.

Generally, the wave shaping circuit for providing the modified electrical signal is an independent generator. Therefore, the only function of the original A.-C. signal is to trigger the generator into an "on" condition. The output may then be amplified and converted to sound by any suitable speaker system.

As a consequence of the use of trigger type circuits, there have resulted two major problems: First, if the original A.C. signal from the transducer is relatively weak as a consequence of low volume playing on the part of the musician, there may not be sufficient energy to trigger the wave shaping circuit or, on the other hand, there may be just sufficient energy at moments to cause a triggering. In either event, the wave shaping circuit will either be silent or emit a constant volume tone the same as though the original tone had been at full volume. Thus, there is possible an erratic operation at threshold triggering voltages for the circuit.

The second problem involved is the very fact that the output of the wave shaping circuit is generally a constant volume tone signal so that the dynamics of the output signal do not follow the dynamics of the input signal insofar as volume control is concerned. It would be highly desirable, for example, if the output signal could follow the same dynamic range as that effected by the musician himself in playing the instrument. Such an arrangement would provide a far more faithful reproduction of the musician's attack.

With the foregoing in mind, one important object of this invention is to provide a novel tone level control circuit which is arranged to pass a modified A.-C. signal from a wave shaping circuit only when the original A.-C. triggering signal exceeds a given threshold level to the end that the effect of erratic operation of such wave shaping circuits is wholly eliminated in the output tone.

Another equally important object is to provide a tone level control circuit in which the modified A.-C. signal from a wave shaping circuit is caused to vary in volume in accordance with amplitude changes in the original A.-C. signal from which the modified signal is derived. By this arrangement, the dynamic range of the resulting output tone follows the dynamic range effected by the musician when playing the instrument.

Briefly, these and other objects and advantages of this invention are attained by feeding the original A.-C. signal into a rectifier-filter combination to produce a D.-C. control signal which will vary in direct accordance with the original A.-C. signal. The circuitry then includes a semiconductor element preferably in the form of an amplifying transistor which is biased to conduct only when a given threshold voltage of the original A.-C. signal is exceeded. The modified A.-C. signal from the trigger circuit or other wave shaping circuit is then fed to the base of the transistor and will only be passed in an amplified form when the transistor is conducting.

By employing a transistor amplifier, the gain thereof may be varied in accordance with the D.-C. controlling signal applied to its base so that the amplified output of the modified A.-C. signal varies in volume in accordance with volume changes in the original A.-C. signal. Thus, the dynamic range of the output signal automatically follows the dynamic range of the input signal.

A better understanding of the invention will be had by referring to a preferred embodiment thereof as illustrated in the accompanying drawings, in which:

FIGURE 1 is a block diagram illustrating various components making up the tone level control circuit of this invention; and,

FIGURE 2 is a diagram showing in detail the novel portions of the circuit of FIGURE 1.

Referring first to FIGURE 1, the block **10** represents a musical instrument connected to a transducer **11** feeding a wave shaping circuit **12**. The instrument **10** may, by way of example, be an electric guitar and the transducer **11** a simple pickup coil for converting the vibrating string motion into an electrical A.-C. input signal. The wave shaping circuit **12** may comprise, for example, a frequency doubler or divider. In many instances, the circuit **12** is characterized by the fact that it will provide an output signal on the line **13** whenever an input signal is received to trigger the same. Thus, the output signal appearing on the line **13** in the form of a modified A.-C. signal will generally be of a constant volume regardless of the volume of the original A.-C. input signal.

The constant volume signal appearing on the output line **13** is amplified and passed to a speaker for reproduction. However, since the output volume is constant, it will appear the same regardless of the actual amplitude of the controlling input original A.-C. signal to the wave shaping circuit. Thus, the dynamic range exercised by the musician would not be reflected in the actual modified output signal. Further, should the input signal to the wave shaping circuit **12** be of relatively low magnitude, the wave shaping circuit **12** may not be triggered, in which event no output would appear at the speaker. On the other hand, if a very low level tone were of just sufficient magnitude to trigger the wave shaping circuit **12**, a full volume output tone would be heard.

It is to overcome the foregoing problems that the present invention is designed. More particularly, a control amplifier **14** is connected between the output line **13** and speaker **15**. In addition, there is provided a branch line **16** for feeding the original A.-C. signal from the transducer **11** into a rectifier-filter structure **17**. The output of the rectifier-filter constitutes a D.-C. controlling signal on the output line **18** which is passed to the control amplifier **14**. The arrangement is such that the volume of the amplifier **14** is effectively varied by the D.-C. control signal on the line **18** so that the constant volume modified A.-C. signal on the line **13** will sound through the speaker **15** with a dynamic range corresponding to the dynamic range of the original A.-C. signal from the transducer **11**.

The manner in which the foregoing operation is carried out will become evident by referring to the embodiment of FIGURE 2 wherein the rectifier-filter circuit **17** and the control amplifier circuit **14** are shown in detail.

In FIGURE 2, the original A.-C. signal from the transducer **11** passes through the branch line **16** to a diode **D1** and series resistances **R1**, **R2**, and **R3**. Condensers **C1**, **C2**, and **C3** are connected in parallel as shown and provide with the resistances a filter network for the signal from the diode **D1**. The resulting output signal

on the line **18** is a negative D.-C. signal which varies in accordance with amplitude variations in the original A.-C. signal.

Referring now to the detailed circuitry of the control amplifier **14**, there is provided a simple semi-conductor **19** constituting a transistor having base, emitter, and collector terminals **20**, **21**, and **22**. The output line **18** for the D.C. control voltage connects through R4 to the base terminal **20**. The modified A.-C. signal from the wave shaping circuit **12** on line **13** also connects to the base **20** through C4 and C5. Negative voltage —V connects through resistance R6 to the collector **22**. The resistances R7 and R8 connect between —V and ground with their junction connecting to the emitter **21**, thereby providing the emitter with a negative bias voltage. This voltage **23** will keep the transistor from conducting as long as the base **20** is at ground potential as provided by R9, or positive with respect to the emitter. The output to speaker **15** is taken from the collector terminal **22**.

In the operation of the circuit, the transistor **19** will only conduct when the controlling D.C. signal on line **18** is sufficiently negative to bias the base of the transistor more negative than the emitter. Thus, by proper selection of the resistances R7 and R8, the bias on the emitter **21** of transistor **19** may be selected so that the transistor will remain non-conducting until a given threshold voltage is exceeded. Thus, erratic operation as would result on the output of the wave shaping circuit **12** for A.-C. signals less than a given level is blocked.

In addition, it will be evident that the gain of the transistor **19** will vary with the controlling D.-C. signal at the base **20** so that the amplified modified A.-C. signal on the output line **13** at the collector **22** will vary in dynamic range in accordance with the D.-C. controlling signal. Thus, the output signal passed to the speaker **15** will vary in volume substantially in accordance with the original A.-C. signal even though the transistor is simply amplifying a constant volume modified A.-C. signal from the line **13**.

Because the transistor is not operating on the linear portion of its curve, the dynamic range at the output may exceed the dynamic range of the original signal. It is therefore desirable to provide means to insure control over the dynamic range. This means, as illustrated in FIGURE 2, is achieved by connecting a resistance **R10** across the collector and emitter terminals **22** and **21**. When the controlling D.-C. signal becomes more negative than the bias voltage at the emitter, the transistor will conduct with the resistance **R10** introducing a degenerative effect. The greater the forward bias, the greater will be this degenerative effect between the collector and emitter. The value of **R10** may be changed

to vary the degree of correspondence between the output dynamic range and that of the input signal.

From the foregoing description, it will thus be evident that the output signal applied to the speaker **15** may be made to vary a volume or dynamic range in a manner precisely the same as the original A.-C. input signal from the transducer **11**. Further, there is eliminated any possibility of erratic operation as a consequence of the on-off characteristic of the wave shaping circuit by selecting a proper bias level for the transistor.

While only one particular embodiment of the invention has been shown and described, various equivalent means for achieving the same results will occur to those skilled in the art. The tone level control circuit is therefore not to be thought of as limited to the exact embodiment set forth merely for illustrative purposes.

What is claimed is:

In a musical instrument including a transducer for converting a musical tone into an A.-C. signal and a wave shaping circuit responsive to said A.-C. signal for providing an output signal for reproduction, a tone level control circuit including: rectifier and filter means connected to rectify and filter said A.-C. signal to provide a D.-C. control signal; and amplifying transistor element having base, emitter, and collector terminals, said D.-C. control signal and said output signal both being applied simultaneously to said base terminal; biasing means connected to said emitter of said transistor to hold said transistor non-conducting until said D.-C. control signal exceeds a given level to render said transistor conducting whereby said output signal is passed to the output of said transistor only when said D.-C. control signal exceeds a given level and thereafter is varied in accordance with variations in said D.-C. control signal; and a resistance connected between the collector and emitter terminals of said transistor to provide a degenerative action when the D.-C. control signal exceeds the bias voltage of said transistor at the emitter, thereby limiting the amplification factor of the transistor to bring the dynamic range of the output signal from the transistor into correspondence with that of the original A.-C. input signal.

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