United States Patent

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[54] **SPEAKER PROTECTIVE CIRCUIT**

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[56] **References Cited**

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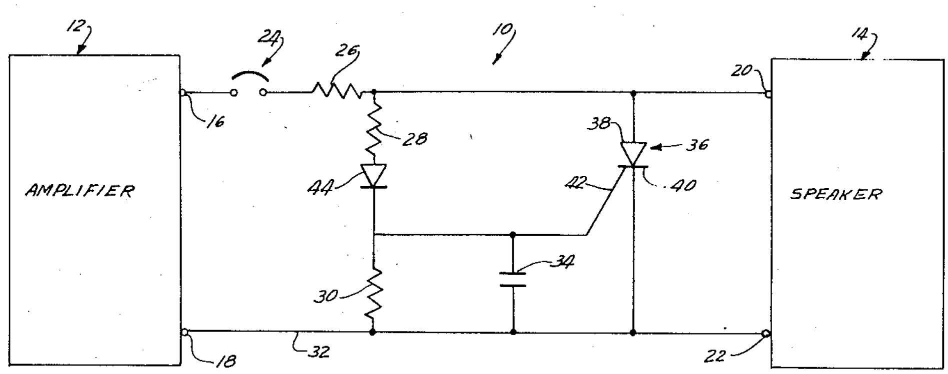
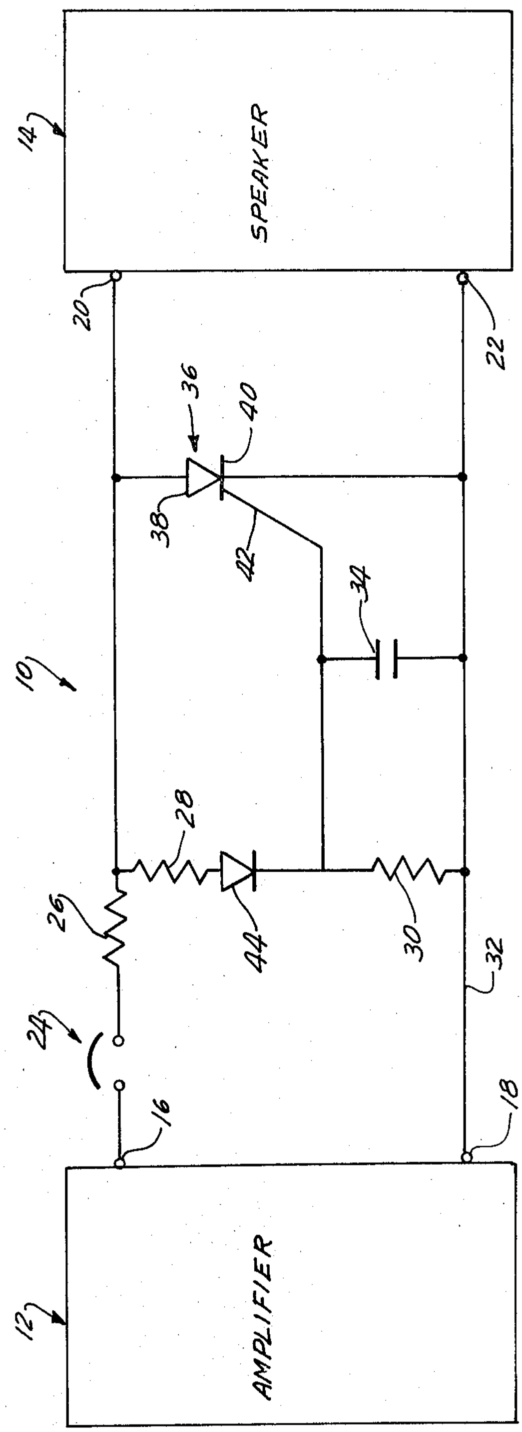
[57] **ABSTRACT**

A speaker protective circuit is provided designed to be interposed between the speaker transducer and driving signal source. The protective circuit includes a silicon controlled rectifier shunted across the transducer adapted to fire in response to either repetitious, intermittent power surges or continuous high level surges and a circuit breaker in series connection with the driving signal source adapted to open circuit in response to long duration power surges or a series of closely spaced short duration surges.

1 Claim, 1 Drawing Figure





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SPEAKER PROTECTIVE CIRCUIT

BACKGROUND OF THE DISCLOSURE

The present invention relates to a protective circuit for acoustical speakers and more particularly, to a protective circuit for use with electrostatic type speakers.

The availability of high power, high quality audio amplifiers with low impedance outputs provides an excellent input source for high quality, full range electrostatic speakers and head phones. Since electrostatic transducers have an input voltage limit after which arcing and dielectric breakdown occurs, they must be provided with some effective means of limiting their input to protect them from going into nonlinear operation. In addition, overloading of any acoustical speaker can result in permanent damage to the speaker or possibly, to the ears of the listener.

Heretofore, various schemes have been suggested to prevent the overloading of speakers. The fuse or circuit breaker, both of which are relatively slow acting devices, have been used to open circuit the speaker from its power source after a threshold level driving signal has been exceeded. Both these devices operate by heating a sensing element and thus, are more or less time dependent, having an inherent time lag determined by the heating time required. Thus, while the fuse type limiting device is effective for relatively long-term power control, it is ineffective for instantaneous control (i.e., where there is a short duration voltage surge).

In certain telecommunication applications, the function of limiting the input voltage is performed by a device which, instead of opening a circuit, shunts the available current and short circuits the excitation potential. These devices are available in various forms of biased diodes and they are frequently used to limit transients in noisy power lines. The use of biased diodes, however, produces very high levels of distortion, particularly if the input signal has high level transients which are relatively short in duration. For a communication system not primarily concerned with distortion-free sound reproduction, the use of biased diodes has proved to be economical and efficient. However, the use of this protective method in a high quality audio reproduction device has heretofore been unsatisfactory.

Thus, in view of the above, it is the principal object of the present invention to provide a single protective circuit for a high quality audio speaker designed to combine the advantages of the various prior art limiting devices and to compromise their shortcomings.

SUMMARY OF THE INVENTION

The above and other beneficial objects and advantages are attained in accordance with the present invention by providing a speaker protective circuit adapted to be interposed between the output of a speaker driving device and the input to a speaker transducer connected to the driving device. The protective circuit comprises fuse means connected in series with the driving device and a silicon controlled rectifier shunted across the speaker input. A first resistor series connected to a second resistor is shunted across the driving device output and the gate of the silicon controlled rectifier is connected to the junction of the first and second resistors.

The output signal of the speaker driving device is sampled by the voltage divider defined by the first and second resistors. If the potential at the junction of the resistors exceeds a predetermined threshold level, the silicon controlled rectifier will be fired, thereby shorting the speaker input substantially instantaneously. The silicon controlled rectifier remains conductive as long as the sampled signal exceeds the threshold level, thereby keeping the speaker shorted. If the speaker is shorted out for a sufficiently long time, the fuse (circuit breaker) will open thereby permanently disconnecting the speaker from the driving device.

A capacitance device may be shunted across one leg of the voltage divider to store part of the sampled signal for a short time duration so that the fuse will open by virtue of either a relatively long duration power surge or a closely spaced series of instantaneous peaks.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawing is a schematic representation of the speaker protective circuit of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the accompanying drawing, the protective circuit **10** of the present invention is shown interposed between the output of an audio amplifier **12** and a speaker **14**. While the present protective circuit may be used with either dynamic or electrostatic speakers, it is particularly well suited for use with electrostatic speakers since such speakers are especially susceptible to damage from high voltage surges and such surges could do permanent damage to the speaker diaphragm.

Amplifier **12** includes an output terminal **16** and return terminal **18** which is commonly maintained at ground potential. Speaker **14** is provided with a pair of terminals **20** and **22** which ordinarily are connected to the amplifier output terminals **16** and **18**.

As stated before, the speaker protective circuit **10** of the present invention is interposed between amplifier **12** and speaker **14**. The protective circuit includes a fuse member **24** connected in series with the amplifier output terminal **16**. Fuse **24** may comprise any device which open circuits when the current passing through it exceeds a predetermined level. Although a conventional fuse comprising a strip of wire that melts when the level is exceeded may be used, an electromagnet-type circuit breaker is preferred since the circuit breaker may readily be reset and the circuit completed without necessitating the replacement of a component. The output of amplifier **12** is fed to speaker **14** through fuse **24** and speaker input terminal **20**. The resistance of fuse **24** is represented in the schematic by resistor **26**.

A voltage divider, formed of two series connected resistors **28** and **30**, extends between the junction of fuse **24** and the speaker input **20** and the return lead **32**. A capacitor **34**, shunted across resistor **30**, and a silicon controlled rectifier **36** complete the present protective circuit. The anode **38** of the SCR is connected to the junction of resistor **26** and speaker terminal **20** and the cathode **40** is connected to the return lead **32**. The SCR gate terminal **42** is connected to the junction of resistor **30** and capacitor **34**. A diode **44** is provided in series with resistor **28** insuring the polarity of the voltage applied to capacitor **34**.

In operation, the driving signal from amplifier **12** to speaker **14** is sampled via resistors **28** and **30**. Part of the sampled signal is rectified and stored in capacitor **34**. The value of the stored signal is determined by the ratio of resistors **28** and **30**. When capacitor **34** charges to the point where it gates the silicon controlled rectifier **36**, the SCR becomes conductive thereby shorting out the speaker. The current through fuse **24** will then rise sharply so that if the silicon controlled rectifier remains fired for a sufficiently long time, fuse **24** will open thereby disconnecting speaker **14** from amplifier **12**. Similarly, a series of peaks spaced sufficiently close to one another to maintain the charge on capacitor **34** at a level to trigger SCR **36** will have the same effect. Thus, after a sufficient number of such peaks, fuse member **24** will also open circuit.

The response time for fuse member **24** and the signal level at which SCR **36** is triggered is determined by the value of the components which, in turn, are determined by the chosen threshold values. In practice, it is suggested that the present circuit be designed so that the SCR fires in response to an output signal of approximately 110 dB sound pressure and the fuse member have a response time of approximately 500 milliseconds. As stated, the response of the SCR is substantially instantaneous so that the interruption of signals above the threshold level is sufficiently rapid that the shorted signal is virtually unheard by the listener.

Thus, in accordance with the above, an improved (audio speaker) protection circuit is provided. It should be realized that although a specific embodiment of the invention has been described and illustrated, various changes therein may become evident to one skilled in the art which do not depart from the scope of the invention as set forth in the appended claims.

Having thus described the invention, what is claimed is:

1. A speaker protective circuit interposed between a speaker driving device and a speaker transducer element, said protective circuit being adapted to prevent audio signals from said driving device above a predetermined cumulative level from passing to said transducer element, said circuit comprising: fuse means connected in series with said driving device; a silicon controlled rectifier shunted across said speaker transducer element; a first resistor and a diode series connected to a second resistor connected in parallel with said driving device and said speaker transducer element, said diode having an anode connected to said first resistor and a cathode connected to said second resistor, the value of said resistors being such that the potential at the junction of said second resistor and said diode cathode is sufficient to gate said silicon controlled rectifier when the output level from said driving device reaches said predetermined level; connecting means extending between the gate terminal of said silicon controlled rectifier and said junction; and, a capacitor shunted across said second resistor whereby to maintain the potential at said junction for a predetermined time period.

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