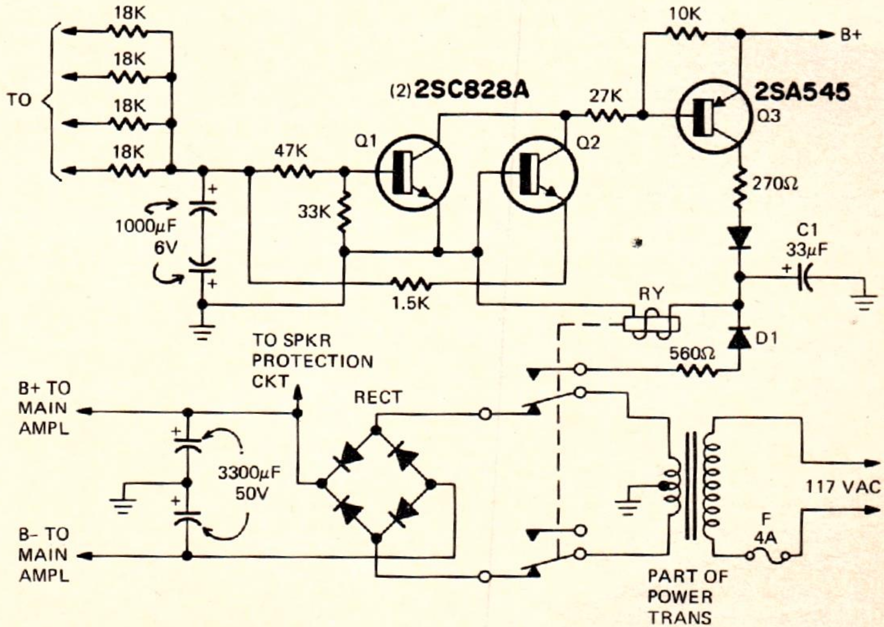
p—k—r pr—t—ction

Electronic circuit protects speakers from damage that might be caused by dc applied because of an amplifier component failure

Loudspeaker protection in Panasonic's model SA-6800X FM/AM 4-channel receiver is provided by this electronic circuit that prevents the speakers from being damaged by dc that might be present at the speaker terminals due to a defect in the output amplifier circuitry. The input to Q1 is bridged across the output terminals of each of the four power amplifiers through 18K-ohm resistors.

A dc voltage present on any of the output terminals is integrated by the 18K-ohm series resistor and the two 1,000-μF electrolytic capacitors. Q1 turns on if the dc voltage is positive and Q2 turns on when the voltage is negative. Conduction in either Q1 or Q2 turns on Q3 and operates the relay. When the relay pulls in the rectifier bridge is disconnected from the power transformer so the dc supply voltages drop to zero. The relay is then held in by dc supplied by D1 and C1. **R-E**



well be that loudspeaker systems are the most poorly defined components in a high-fidelity system, in terms of their performance. It is virtually impossible to pick up two or more so-called specification sheets relating to speaker systems from as many manufacturers and make valid comparisons as to their relative quality or ability to reproduce musical programming accurately.

When you consider that the loudspeakers are, after all, the only component in the system that you *hear,* the more consistent and meaningful specifications relating to the electronic components of a system (tuners, preamplifiers, amplifiers, etc.) tend to assume less importance.

Of course, loudspeaker systems are electromechanical devices, and such devices are much more difficult to "pin down" in terms of performance. In addition, loudspeakers do not perform in a "vacuum" or even in an anechoic chamber when they are finally put to practical use. Their relationship to the room in which they are used, the amplifier which drives them and the listener who hears them form a complex physical and psychoacoustic interplay which is only now becoming the subject of much fundamental research and study.

Nevertheless, that does not justify the fact that many of the "specs" ascribed to consumer type home entertainment loudspeaker systems are totally meaningless and still others are quoted using such a great variety of references that the prospective purchaser usually ends up "trusting his ears" or relying upon specifications which have little or nothing to do with the sound he hears.

The Institute of High Fidelity (an organization composed of some fifty leading component high-fidelity manufacturers) has embarked upon a program of updating outdated measurement standards and formulating new ones for those high-fidelity components (notably speaker systems) ... upon a great ...

Diameter Of Transducers– I have heard very accurate bass from an 8-inch woofer and some pretty "muddy", one-note boom produced by massive 15-inch drivers. One of the best selling systems currently on the market uses a multiplicity of 4-inch elements to produce astoundingly good bass. Diameters of mid-range and tweeter elements tell even less about the ultimate sound quality in this region of the audio spectrum.

Free Air Resonance– An interesting parameter of a transducer as far as the speaker system engineer is concerned (it helps him to design enclosures that *minimize* the effects of this mechanical resonance), but absolutely meaningless as far as the end-user is concerned.

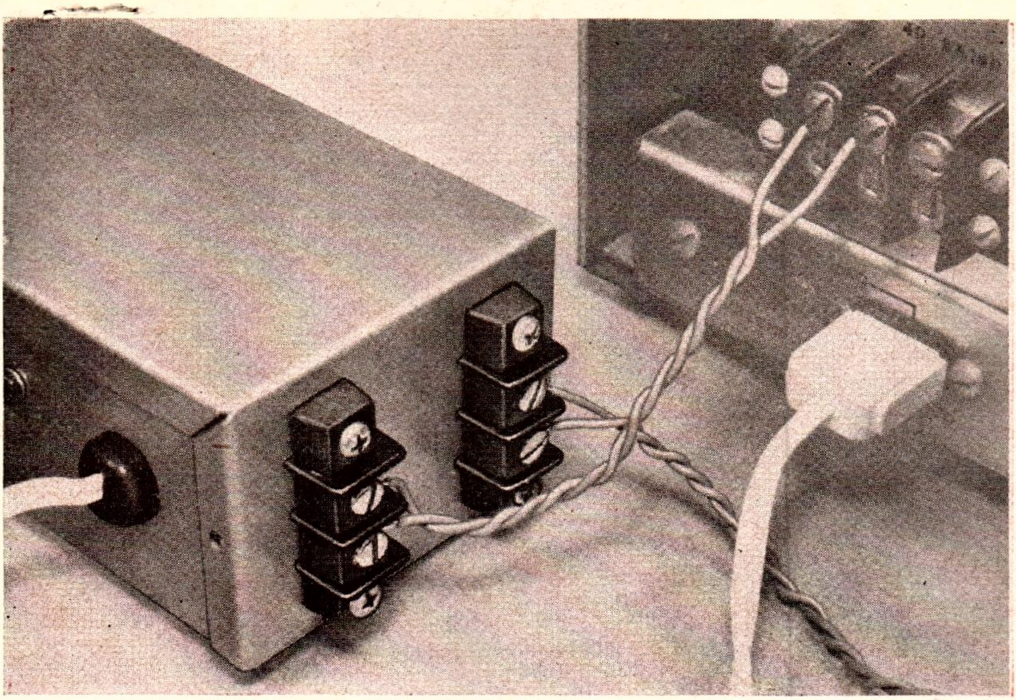
Voice Coil Diameter– Again, this dimension may be helpful to the designer but does not even suggest sonic performance qualities to the purchaser. An analogous spec in an amplifier might be the diameter of the output-transistor housings–interesting, but only very marginally related to the power output capability of the product!

Crossover Frequencies– While this specification may be of interest to the user who plans to use a bi-amp or tri-amp system (separate amplifiers driving the separate transducers in the system–thought by some to be superior to passive L-C crossover systems), most speaker manufacturers who proudly proclaim their various crossover frequencies make no provision for this type of operation.

Let's do away with specs that don't tell the consumer what he's trying to find out–and thereby leave some room on the spec sheet for some meaningful, properly stated specifications!

Speaker specs we need clarified

Frequency response of a loudspeaker system is, of



Build a WOOFER GUARD

SAFETY FIRST FOR SPEAKER CONES

BY PHIL ARTHUR

MANY DIRECT-COUPLED solid-state output amplifiers produce a loud "thump" every time you turn them on or off. Worse still, if their output circuits fail, the full supply voltage (on the order of 37.5-42 volts d.c.) could be delivered to your speaker systems, causing serious damage if not detected in time.

The turn-on/turn-off thump is a result of the supply voltage's being suddenly applied or removed from the output stages of the amplifier. If of sufficient amplitude, these voltage transients can "pop" speaker cones, irreparably damaging your speaker systems. The way to eliminate the thump is to delay the output signal (and, consequently, the transient) until the output voltage is at a safe level for the speakers—especially the woofers which are most prone to damage by the low frequency of the transient.

The other big hazard connected with direct-coupled outputs—short-circuit failures that deliver full supply voltage to the speakers—can be dealt with by the same delay circuit. Since such a delay circuit is voltage sensitive, it would actuate long before the voltage available at the output could attain a damaging level.

The "Woofer Guard" was designed to allow hi-fi buffs to operate their systems with complete safety. Placed between the output terminals of any direct-coupled power amplifier and the speaker systems, it quite literally "guards" the speakers from damage.

About The Circuit. The Woofer Guard is composed of two circuits: a timer which prevents turn-on and turn-off transients from reaching the speakers, and a voltage sensing circuit that "samples" the output voltage of the amplifier to determine whether or not to complete the circuit to the speakers. Resistor *R8*, potentiometer *R9*, and capacitor *C2* in Fig. 1 form an *RC* timing circuit.

Resistor *R8* and potentiometer *R9* allow capacitor *C2* to charge up to about 1.2 volts when voltage is applied to the

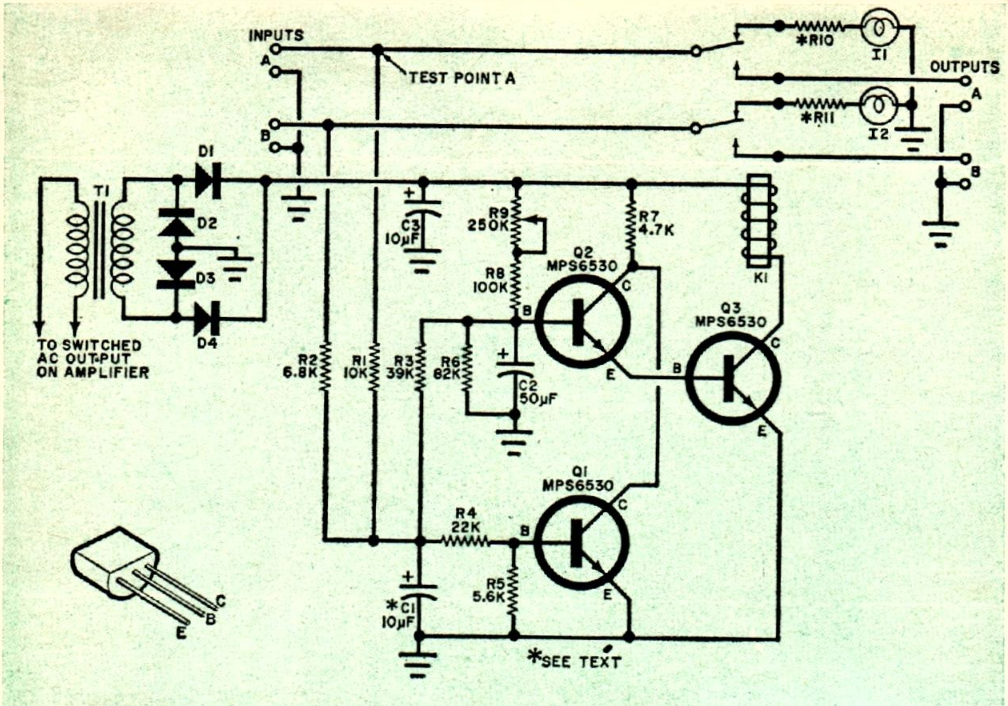


Fig. 1. Any high-level audio signal or constant d.c. voltage detected by amplifier circuit Q1-Q3 causes relay K1 to be deenergized.

PARTS LIST

C1—10-µF, 50-volt electrolytic capacitor (see text)
C2—50-µF, 15-volt electrolytic capacitor
C3—10-µF, 50-volt electrolytic capacitor
D1-D4—100-volt, 0.5-ampere diode
I1,I2—Optional indicator lamp (see text)
K1—D.p.d.t. 24-volt, 600-ohm relay (Allied Electronics No. 41D4659 or similar)
Q1-Q3—Bipolar transistors (Motorola MPS6530, HEP 721, or similar)
R1—10,000-ohm
R2—6800-ohm
R3—39,000-ohm
R4—22,000-ohm
R5—5600-ohm
R6—82,000-ohm
R7—4700-ohm
R8—100,000-ohm
(R1–R8: *All resistors ½-watt*)
R9—250,000-ohm, linear-taper potentiometer
R10, R11—Optional dropping resistors for I1 and I2 (see text)
T1—24-volt, 0.5-ampere filament transformer
Misc.—Aluminum utility box; rubber grommets for I1 and I2; a.c. line cord with plug; screw-type barrier blocks; hookup wire; solder; hardware; etc.

circuit. Since transistors *Q2* and *Q3* are arranged in a Darlington-pair configuration, the transistors are cut off until the charge across *C2* exceeds the sum of *Q2*'s and *Q3*'s emitter-to-base junction voltage (approximately 0.6 for each transistor, or a total of about 1.2 volts). As soon as 1.2 volts is exceeded, *Q2* and *Q3* will immediately go into conduction and cause *K1*, the relay, to be energized which completes the circuit between the amplifier and speaker systems. Now, if a component in the amplifier fails and the amplifier applies a positive or negative voltage, with respect to ground, to the output, the sensing circuit goes into action and reverses the process just outlined, disconnecting the speakers from the amplifier output circuits.

Resistors *R1* and *R2* serve to isolate the Woofer Guard, preventing it from interfering with the normal operation of the amplifier. Capacitor *C1* prevents the sensing circuit from going into action on loud music (high-voltage) passages.

If a positive voltage with a sufficient time duration appears at the output of the amplifier, a portion of this voltage will bias *Q1* into conduction and cause the collector voltage of *Q2* to decrease. This decrease, in turn, cuts off *Q3* and causes *K1* to deenergize and disable the circuits between amplifier and speaker systems.

If a negative voltage is applied to the input of the Speaker Guard circuit, a portion of this voltage would be fed, through *R3*, to the base of *Q2*, biasing both *Q2* and *Q3* into cutoff. Again, with these two transistors cut off, *K1* will be deenergized.

The power supply for the Speaker Guard consists of a simple bridge rectifier and a small-value filter capacitor (*D1-D4* and *C3*). Capacitor *C3* prevents *K1* from "chattering" prior to being fully energized.

The *I1/R10* and *I2/R11* circuits are optional features that provide a visual indication of which output circuit is defective in the event of an amplifier failure. The operation of these circuits is as follows: If channel A malfunctions and supplies the full supply (42 volts) to the Woofer Guard, the voltage-sensing circuit deenergizes *K1* as described above, disconnecting the speaker systems. The elay contacts are now in the positions nown, applying the supply voltage to *I1* rough *R10,* indicating that Channel A nalfunctioning.

he values of resistors *R10* and *R11* be calculated for your given ampli- ince power supply voltages differ mplifier to amplifier, you will have hm's Law to compute the values: , where E is the amplifier's sup- e minus the voltage rating of the lamp, and I is the current rating of the lamp.

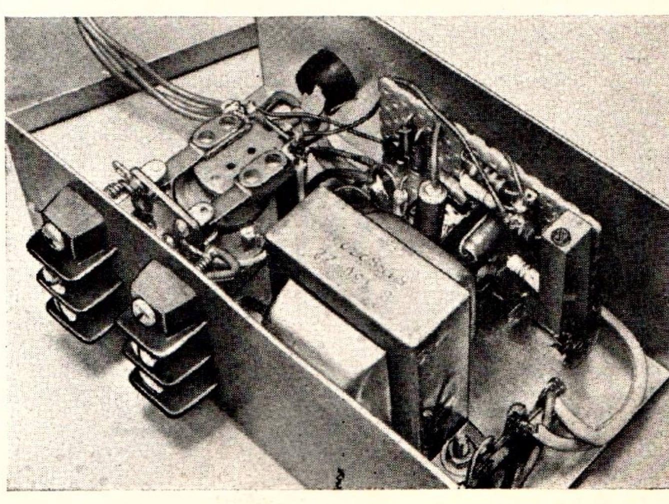
To show how the values of *R10* and *R11* are computed, assume that E is 42 volts and the lamp is rated at 6 volts at 40 mA. Plugging these figures into the Ohm's Law equation, we get: $R = E/I = (42 - 6)/0.04 = 900$ ohms. Then, to obtain the power rating of the resistor, use the power formula: $P = E^2/R = 36^2/900 = 1.44$ watts. Hence, we would use a 900-ohm, 2-watt resistor for the lamp voltage dropper in each channel.

Construction. Due to the simplicity of the circuit, all components (except *T1* and *K1*) can be easily mounted on a small piece of perforated phenolic board as shown in Fig. 2. The board is held in place with #6 hardware and ½" spacers.

Notice that input and output connections are made to separate screw-type barrier blocks. Make sure that, when wiring the blocks up, you do the job correctly. (Note: If your amplifier has one channel that can be switched to reverse the phase, check to make sure that the grounds in each channel are common to each other. If they are not, run separate ground wires for each channel through the Woofer Guard, and do NOT GROUND either of these wires to the chassis of the Woofer Guard or operating the phase reversal switch can damage your amplifier.)

When soldering to the diodes and transistors, exercise caution to prevent heat

ept for relay, jacks, rmer, all components small piece of perfo- nolic board; use small ts for board mounting.



damage to these components. Use a low-wattage soldering iron, and apply the heat only long enough to get the solder to flow, while protecting the component lead with a heat sink. Also, make sure that electrolytic capacitors, diodes, and transistors are installed in the proper lead orientation.

Test and Adjustment. Without the speakers and amplifier connected to the Woofer Guard, plug in the guard's line cord and adjust the setting of *R9* to obtain approximately a 2-second delay before the relay contacts close. Time the delay from the instant the power cord is connected until the contacts close.

To test the voltage-sensing circuit, momentarily touch the positive contact of a 9-volt transistor battery to test point A in the Woofer Guard circuit; the negative contact goes to the COMMON input terminal. The relay should immediately deenergize. Then, by momentarily touching the battery contacts to the same points in the Woofer Guard circuit in the opposite direction, the relay should again almost immediately deenergize.

HIRSCH-HOUCK LABORATORIES

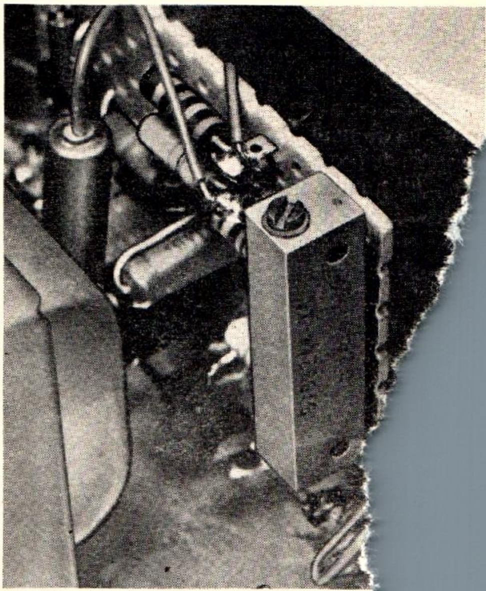
Project Evaluation

Tested on the laboratory workbench, it was found that the relay in the Woofer Guard dropped out with as low as ±3 volts d.c. applied to the inputs. It seemed a little sluggish at this low voltage (perhaps 0.5-second operating time), but at 5 volts or more, it operates in about 0.1 second. The release time after dropping out is on the order of 2 seconds.

Low-frequency audio signals were tried to determine what would trip the Woofer Guard. A sine wave of 10 volts r.m.s. at 5-6 Hz was capable of tripping the circuit, but a 9-volt peak-to-peak square wave of *any* frequency up to 50 kHz would also trip it. This is consistent with the static operation (d.c.) of the device, since it operates on both polarities; the square wave appears to the Woofer Guard as a d.c. input of about 4.5 volts.

The Woofer Guard was then connected between an Acoustic Research receiver and a pair of 8-ohm speakers. It trips on the muting "thump" if the volume setting on the amplifier is somewhat above the normal listening level, or if any great amount of bass boost is used. The only way the Woofer Guard was made to trip when fed with program material was to play the amplifier at very high levels, preferably with bass boost.

The Woofer Guard protects only the woofer in a speaker system, but the tweeter in many cases is more vulnerable. Even though few amplifiers have direct-coupled outputs, there is always the chance that the blocking capacitor will break down and place half of the supply voltage in the amplifier across the speaker system. The Woofer Guard should take care of such a situation nicely.



Long block shown in foreground is spec
potentiometer. You can substitute comr
able printed circuit type pot of appror

Now, assemble the Woofer G
case and connect it to your am
outputs and speaker systems. In
you might notice that the Woofer G
disconnects your speaker systems
high-level, low-frequency notes (about
watts r.m.s./channel below 20 Hz).
you find this annoying, you can repla
C1 with a 20-μF capacitor. –30