Automatic Audio Panner

Special-audio-effects device automatically creates dynamic stereo sound from monophonic audio signals such as produced by electric guitars

By C.R. Fischer

Special-effects devices have always been popular among modern-day musicians and tape recordists, whether professional or amateur. Among the creative sound effects they make possible is "panning," which is controlling a signal so that it is positioned at some perceived location between left and right speakers. Placing the sound somewhere within a stereo panorama (hence the name "panning") is often done manually with a mixer control called a "panpot." In home stereo systems, such a control is commonly called a balance control.

Making the audio move between two speakers *automatically* opens new, dramatic sound opportunities, especially when combined with signal level, depth and rate controls, as the subject of this project does. Devices that produce such special effects are called autopanners. Commercial ones are usually quite costly, The one presented here, which we call "Autopanner," is not. Yet it can inexpensively allow any mono electric musical instrument or other audio source to produce innovative sounds that spell the difference between amateur and pro.

About the Circuit

As shown in Fig. 1, the Autopanner is composed of six sections: an input buffer, a pair of voltage-controlled amplifiers (vca's), a low-frequency oscillator (lfo), a control-voltage processor and a power supply. These sections are designed to work together with a minimum of noise and distortion.

Figure 2, shown in two parts, is the complete schematic diagram (sans power supply) of the Autopanner's circuitry. The portion shown in Fig. 2(A) is an input buffer and preamplifier built around dual low-noise operational amplifier *IC1*. The buffer has a reasonably high input impedance to minimize loading down signal sources like electric-guitar pickups, which can result in a loss in high frequencies and overall volume when the signal is reproduced through the stereo system's speakers.

LEVEL control *R2* provides a means for adjusting the gain of the preamp from 0 to 5 so that the Autopanner can be used with a variety of input signal levels. The other half of the op amp is wired as a comparator that lights CLIP *LED1* whenever an excessively high input signal level is applied to the project's input via AUDIO INPUT phone jack *J1*. Therefore, *R2* should normally be set so that *LED1* never quite turns on.

The dual vca's are the center of action in the Autopanner. A voltage-controlled amplifier has variable gain that is controlled by an input voltage. (For more vca circuit designs, see "Using The Transconductance Amplifier" *Modern Electronics*, September 1986.)

Because building a high-quality vca is not an easy task, a quad vca chip (*IC2*) designed for music synthesizers was used in the Autopanner. This SSM 2024 IC features low noise, low distortion and wide band-

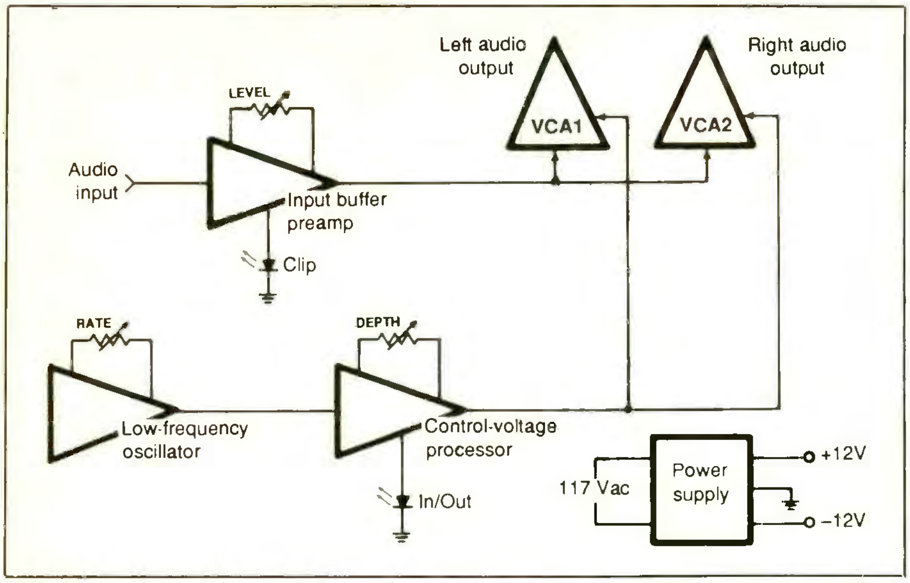

Fig. 1. Autopanner is composed of six circuit "blocks," including power supply, that work together with minimum noise and distortion.

width, and is reasonably priced. Although less-expensive alternatives to the SSM 2024 are available, their use would have resulted in unacceptable noise and distortion levels.

Since the two vca's are identical (except for the different control-voltage sources), we will examine only one in detail. Attenuator *R6/R7* prevents overloading the low-level vca input. Trimmer potentiometer *R9* allows you to null out any voltage offset that appears at the input. (Offsets tend to cause "thumps" in the output whenever the control voltage is changing rapidly. With proper calibration of *R9*, this thumping can be made inaudible.)

The SSM 2024 has low-level, high-impedance current outputs that require amplification so that they can be boosted to usable signal levels. Dual op amp *IC3* provides that amplification, with *R14* setting the output level and *C3* contributing to amplifier stability.

DEPTH potentiometer *R21* controls the amount of triangle-wave signal applied to both vca's. Lower-level settings result in a subtle "shimmering" effect, while higher-level settings cause the signal to alternate between the speakers.

Almost all effects devices require some sort of input/output switching to allow the musician or audio engineer to turn them on and off as desired. It is a good idea to use a control signal to switch in and out the effect to avoid running the audio signal

PARTS LIST

Semiconductors
D1—1N914 or similar silicon switching diode
IC1,IC3,IC4,IC5—TL 072 dual bi-FET operational amplifier (or 1458 or 4458 op amp for IC4 and IC5)
IC2—SSM 2024 quad voltage-controlled amplifier
LED1,LED2—T-1¾ red light-emitting diode
IC6—7812 + 12-volt regulator
IC7—7912 − 12-volt regulator
Q1—General-purpose n-channel field-effect transistor
RECT1—50-PIV, 1-ampere bridge rectifier

Capacitors (25 WV or greater)
C1,C6 thru C9—0.1 μF ceramic or polyester
C2,C3—100 pF mica
C4,C5,C13,C14—4.7 μF tantalum
C10—2 μF nonpolarized aluminum
C11,C12—2,200 μF electrolytic

Resistors (¼-watt, 10% tolerance)
(Note: metal-film resistors are preferred—see text)
R1,R25—220,000
R3,R22,R26 thru R29—100,000 ohms
R5,R23—1,000 ohms
R6,R10—4,700 ohms
R7,R11—220 ohms
R8,R12—1.5 megohms
R14,R15,R30,R31—10,000 ohms
R17—820 ohms
R18,R20—33,000 ohms
R19—12,000 ohms
R24—22,000 ohms
R2—1-megohm, linear-taper potentiometer
R4—50,000-ohm multi-turn pc-type trimmer potentiometer
R9,R13—100,000-ohm multi-turn pc-type trimmer potentiometer
R16,R21—100,000-ohm, linear taper potentiometer

Miscellaneous
F1—0.25-ampere slow-blow fuse
J1—Closed-circuit phone jack
J2 thru J4—Phone jack
S1,S2—Spst slide or toggle switch
T1—12.6-volt ac, 100-mA power transformer (see text)
Perforated board with holes on 0.1" centers, DIP IC sockets and soldering or Wire Wrap hardware for circuit board; holder for F1 (see text); ac line cord with plug; suitable enclosure; 2-lug terminal strip with neither lug connected to mounting tab; rubber grommet for line cord; knobs for panel-mount potentiometers; jack for plug-in power transformer (optional—see text); spst footswitch with phone plug (optional—see text); lettering kit; machine hardware; hookup wire; solder; etc.

Note: The SSM 2024 quad voltage-controlled amplifier chip is available for $6.25 PPD. (California residents, please add 6.5% state sales tax) from Mescal Music, P.O. Box 5372, Hercules, CA 94547.

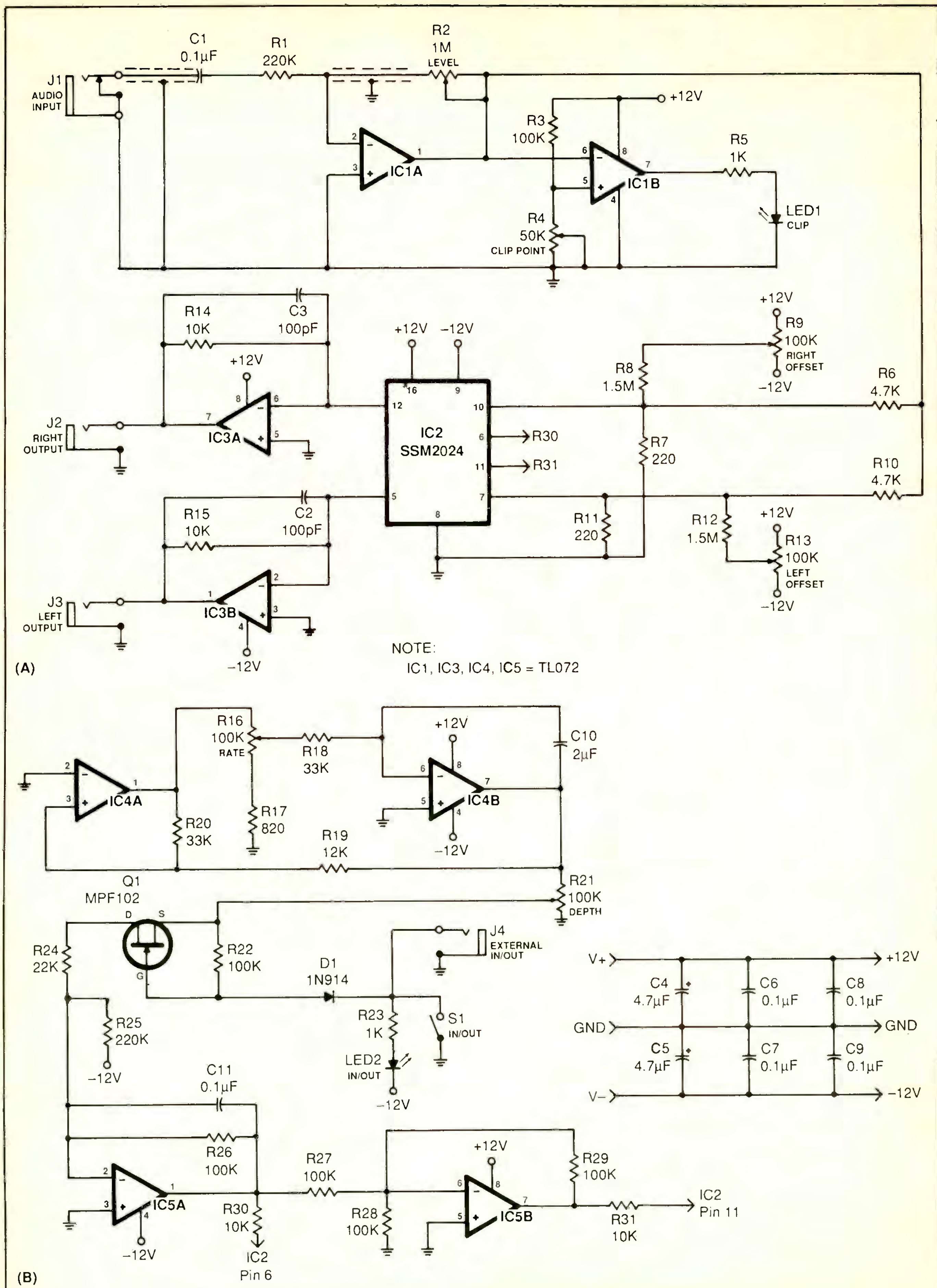

Fig. 2. Schematic diagram of audio (A) and control (B) sections.

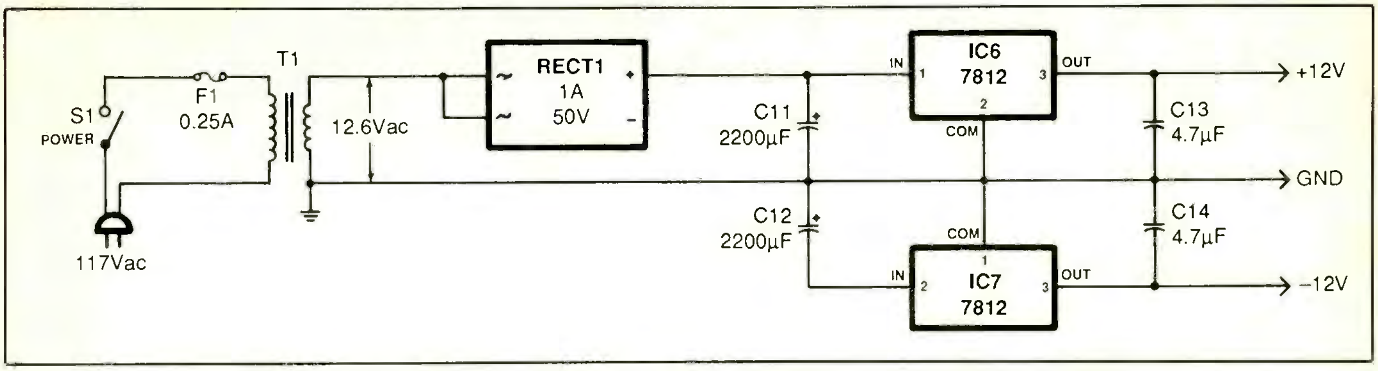

Fig. 3. Schematic diagram of a suitable ac-operated ± 12-volt dc power supply.

itself through long wires to and from a footswitch. To accomplish this, the lfo's triangle wave is applied to field-effect transistor *Q1*.

With INPUT/OUTPUT switch *S1* open, *Q1* is held in cutoff by the negative voltage across *D1/R23* and IN/OUT *LED2*, preventing the lfo waveform from reaching the vca's.

Closing *S1* grounds the I/O point. This causes *LED2* to light, reverse-biases *D1*, and allows the triangle wave to control the vca's.

Since the I/O circuit is a simple logic design that is either grounded or floating, an spst footswitch can be connected to the circuit via EXTERNAL IN/OUT jack *J4*. A cable as long as needed can be used without causing signal degradation. You can then use the footswitch instead of *S1* to switch in and out the Autopanner's effect. IN/OUT *LED2* will glow slightly when off due to leakage current from *Q1*. However, the difference between the "on" and "off" settings is large enough to avoid confusion. With the effect off, the Autopanner sends the input signal to both outputs.

Dual op amps in *IC3* serve as inverting amplifiers that drive the vca. Amplifier *IC3A* sets the proper gain range with *R24*, *R25* and *R26*, and *C11* acts as a crude filter to eliminate any small glitches that might be generated whenever one vca is at full gain and the other is off. Current limiting to the vca control-voltage inputs is provided by *R30* and *R31*.

A bipolar power supply that has outputs between +9 and +15 volts is needed to power the Autopanner. The schematic diagram for a suitable + 12-volt power supply is shown in Fig. 3. Instead of using the center-tapped power transformer usually found in bipolar power supplies, this one uses a transformer with an untapped secondary winding. This gives you the option of using a plug-in ac transformer if you wish, allowing the Autopanner to be built into a smaller enclosure than would otherwise be needed and preventing any ac field from showing up in the project's outputs.

Construction

For best results, use perforated board that has holes on 0.1-inch centers on which to mount the components that make up the project's circuitry. Use sockets for the ICs and appropriate soldering or Wire Wrap hardware for component-lead connections. Keep all component leads as short as possible, and make sure to include bypass capacitors *C6* through *C9* in Fig. 2. (As you wire the board, install only the IC sockets —*not* the ICs themselves—and save IC installation until after initial voltage checks have been performed.) With a little care in laying out the components and routing the wiring, you should be able to obtain professional-quality operating results.

If you demand the very highest in operating quality, several improvements can be made for a slight increase in the cost of the project. For example, you can use metal-film resistors and high-quality mica and polystyrene capacitors in the audio circuitry around *IC1*, *IC2* and *IC3*. Because resistor noise is proportional to resistance, it is an especially good idea to use a metal-film resistor for input resistor *R1*.

After wiring your circuit-board assembly, you can mount it inside a metal or plastic enclosure, an example of the latter illustrated in the lead photo. If you are using an internal power supply, mount it in a location at the rear of the enclosure where it and the incoming ac line cord will be as far away from the input and output jacks on the rear panel and the input audio circuitry on the board. Use a two-lug terminal strip (neither lug grounded) to make the line-cord to transformer primary connections. If you use an external plug-in supply, mount on the rear panel a suitable jack to accommodate the connector at the end of its cord.

All controls and the light-emitting diodes mount on the front panel and all input/output jacks mount on the rear panel of the enclosure. After drilling the required holes, deburr them if the enclosure is of metal construction. Then label the controls, LEDs and jacks with appropriate legends (see lead photo).

Fuse *F1* can be mounted inside the enclosure using an inexpensive chassis-mount fuse block. Alternatively, you can mount the fuse in a bayonet-type holder mounted on the rear wall of the enclosure. POWER switch *S2* can be a slide or toggle type and can be mounted either on the front or rear (preferred location) of the enclosure or can be eliminated altogether if you prefer.

Keep in mind that the cables between INPUT jack *J1* and the circuit board and between LEVEL control *R2* and the junction between *R1* and pin 1 of *IC1* must be shielded. Ground the shields of these two cables at only one end to avoid feedback.

When you wire the various panel-mounted and trimmer controls into the circuit, make sure that the wiring is done so that their effect *increases* when they are adjusted clockwise!

Figure 4 is a photo of the interior of the author's completed Autopanner prototype. Note the neat layout of the components on the circuit-board assembly and off the board. Try to emulate this layout as much as possible to avoid interference effects when the project is put into service.

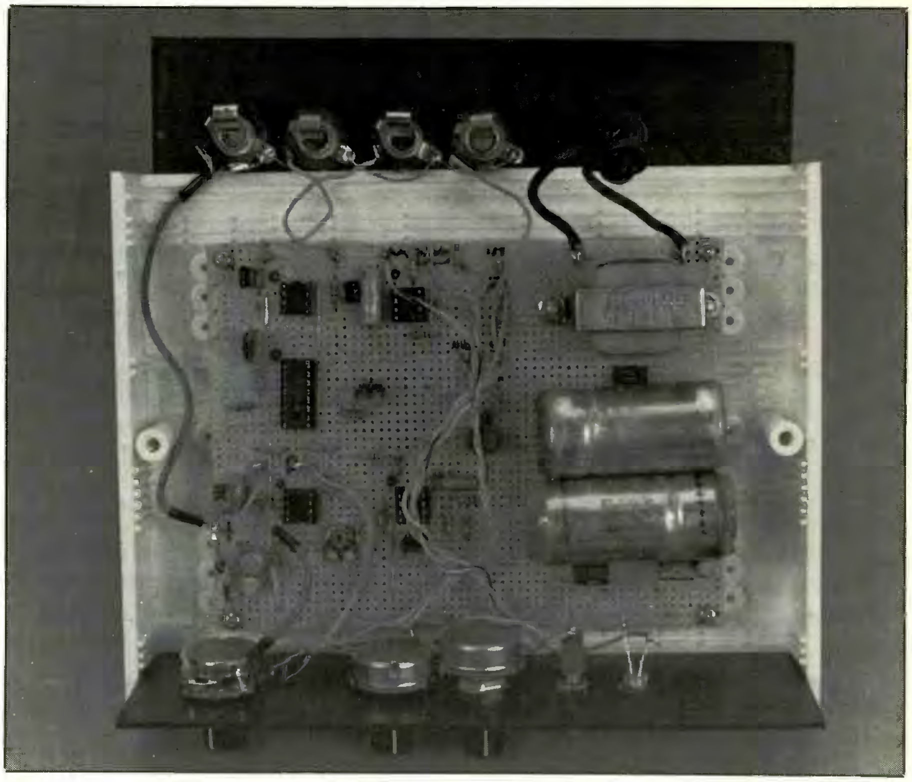

Fig. 4. Interior view of assembled prototype. Note clean layout of components both on and off the board.

Test & Calibration

With the ICs still not installed in their sockets, plug the Autopanner's line cord into an ac outlet. Set a multimeter to the dc volts function and its range switch to a setting that will allow you to measure up to 20 volts or so. Connect the meter's common probe to any circuit ground point and leave it there as you make your preliminary voltage checks.

Touch the meter's "hot" probe to the positive (+) lead of *C1* and then the negative (−) lead of *C2*, noting the readings obtained in both cases. Your meter readings should be +12 volts on the positive lead of *C1* and −12 volts on the negative lead of *C2*, assuming you are using the Fig. 3 power supply. If you are using an external plug-in power transformer that has a different voltage on its secondary, the readings should be between +9 and +15 volts on the positive lead of *C1* and between −9 and −15 volts on the negative lead of *C2*.

Touching the meter's hot probe to the pin 8 socket terminals for *IC1*, *IC3*, *IC4* and *IC5* should yield the same positive voltage reading obtained on the positive lead of *C1*. The same applies when taking a reading at the pin 16 socket receptacle for *IC2*. Similarly, you should obtain the same negative voltage reading as measured on the negative lead of *C2* when you touch the meter's hot probe to the pin 4 socket receptacles for *IC1*, *IC2*, *IC4* and *IC5* and the pin 9 socket receptacle for *IC2*.

If you do not obtain the proper reading at any or all of the IC socket pin receptacles, power down the circuit and carefully recheck your wiring against Figs. 2 and 3. Also, check particularly for proper electrolytic capacitor orientations.

When you are certain that your wiring and component installation are correct, power down the project and allow the charges to bleed off the electrolytic capacitors. Then install the ICs in their respective sockets. Make sure you properly orient each IC as you install it and that no pins overhang the sockets or fold under between ICs and sockets.

If you have a sine-wave generator, turn its level control completely down and plug its line cord into an ac outlet and its output cable into the Autopanner's AUDIO INPUT jack. If you do not have a sine-wave generator, use a musical instrument instead.

Turn the volume control of your stereo amplifier all the way down and connect the Autopanner to the inputs of the amplifier. Turn on the generator, amplifier and Autopanner. Turn up the Autopanner's LEV-

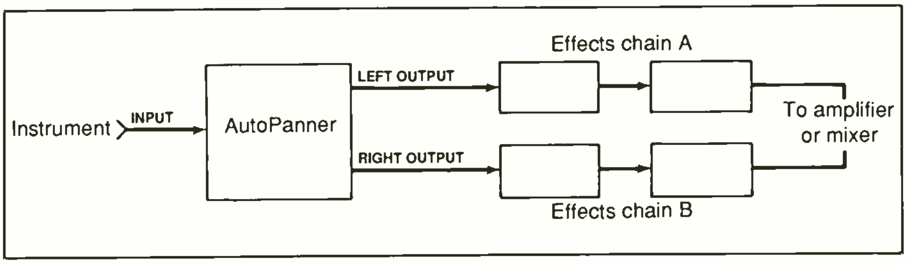

Fig. 5. In addition to stereo panning, Autopanner can be used to fade between groups of special-effects devices.

EL control to about mid-position and set its RATE and DEPTH controls fully clockwise. Set the project's IN/OUT switch to "on" (or step on the footswitch, if you are using it, to close its contacts). Slowly raise the setting of the amplifier's volume control. Then adjust the generator's level control until you hear its signal coming from the speakers.

If everything is working as it should, you should now hear the input signal rapidly alternate between the two speaker systems in your stereo setup. If you hear any distortion at this time, lower the Autopanner's LEVEL control setting until it disappears (ignore the CLIP LED for now; it has not yet been calibrated).

As you adjust the Autopanner's controls the effects should increase. If it is just the opposite, power down the project, disconnect it from the signal generator and stereo amplifier, and transpose the connections going to the two outer lugs of the offending control. Then reconnect the project to the generator and amplifier, repower the system and continue with calibration.

Now adjust both vca's for minimal offset voltages as follows. Lower the setting of the project's LEVEL control to minimum and set your stereo amplifier so that only the right channel can be heard. Adjust the amplifier's volume control upward until you hear a clicking sound and adjust RIGHT OFFSET control *R9* for minimum audible noise. Then set the amplifier so that only the left channel is audible and repeat the procedure with LEFT OFFSET control *R13*.

Final trim involves adjusting the reference voltage at comparator *IC1B* so that the CLIP LED turns on just before the onset of distortion. Turn up the project's LEVEL control setting once again until distortion returns and adjust CLIP POINT control *R4* so that the CLIP LED turns on. It is a good idea to set *R4* so that the CLIP LED comes on just before the onset of distortion to obtain optimum signal-to-noise ratio.

In the event the Autopanner is not operating properly, troubleshooting should be performed in a logical manner. First determine if the input signal is reaching OUTPUT jacks *J2* and *J3*. If there is no output with the LEVEL control turned fully clockwise, immediately power down the project, remove the ICs from their sockets, and recheck the power-supply rails to each IC socket.

Once you have an output signal, troubleshooting the circuit becomes a lot easier to do. You should then determine if the lfo is oscillating and if *Q1* is biased so that the lfo's triangle wave cannot reach the vcas. If there is no "movement" between the outputs, the problem probably lies around *IC3* and/or *IC4* or the input/output circuit.

Using the Autopanner

The most obvious use for the Autopanner is to create a "ping-pong" effect from a mono input. Electric guitars, pianos, organs and synthesizers can all benefit from the animation that dynamic panning provides. While high DEPTH settings may immediately attract the attention of listeners, lower settings can add subtle enhancement that will more readily benefit the music being played. Different rates can be selected, depending on the tempo or "mood" of the music being played.

A more unusual use for the Autopanner's automatic effects is illustrated in Fig. 5. The Autopanner's outputs can be connected to any number of other special-effects boxes, such as phasers, fuzz boxes, echo units, chorus units, etc. As the Autopanner sweeps between outputs, two different sets of effects will be heard with an arrangement like this. This is an interesting way of getting some new sounds.

As with any special effect, that of the Autopanner requires a little practice and experimentation to obtain best results. ME