BUILD A Hi-Fi VOLUME COMPRESSOR EXPANDER

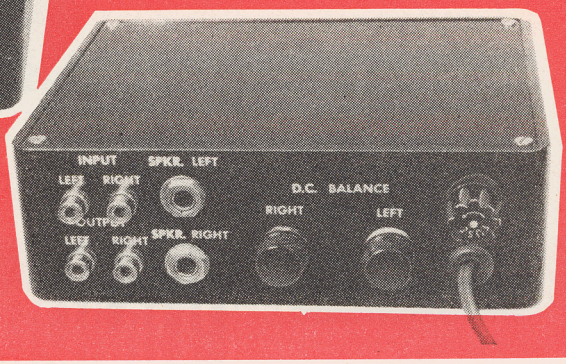
By ROGER H. RUSSELL

Add dynamic realism to FM stereo and to your tapes and records. Superbly designed and inexpensive to build, this little unit is alone in its class

WHILE NEW GADGETS for the audiophile have not been slow in making an appearance on dealers' shelves, at least one has been consistently shoved aside or completely ignored: the volume compressor-expander. Here, for the first time, is a method of controlling the dynamic range of your hi-fi system for less than $25.00. And the low cost is not the only attractive feature. Hirsch-Houck laboratory tests reveal that P.E.'s volume compressor-expander is virtually unmatched in its performance, even when compared to commercial units costing much more.

What exactly is volume compression-expansion? It's as simple as this: The dynamic (loudness) range of live program material is usually much wider than a recorder or broadcast transmitter can handle. If, for example,

Controls at rear of unit are d.c. balance pots which are adjusted initially. A cartridge, tuner, or other audio source is connected to inputs; outputs go to amplifier. Speaker jacks allow unit to sample amplifier output at speakers and react accordingly.



Controls on front of unit (photo above) are threshold controls which determine the level at which expansion or compression takes place. Panel lamps I1 and I2 glow in proportion to the voltage of the audio tapped from speakers; switches control power, function.

the gain is set halfway up, the soft parts will be accompanied by noise (tape hiss, hum, etc.) and the loud parts will be distorted from overdriving the recording or broadcast amplifier. Unfortunately, the solution to this problem—turning up the amplifier on soft passages and turning it down on loud ones—destroys the dynamic range of the original program material.

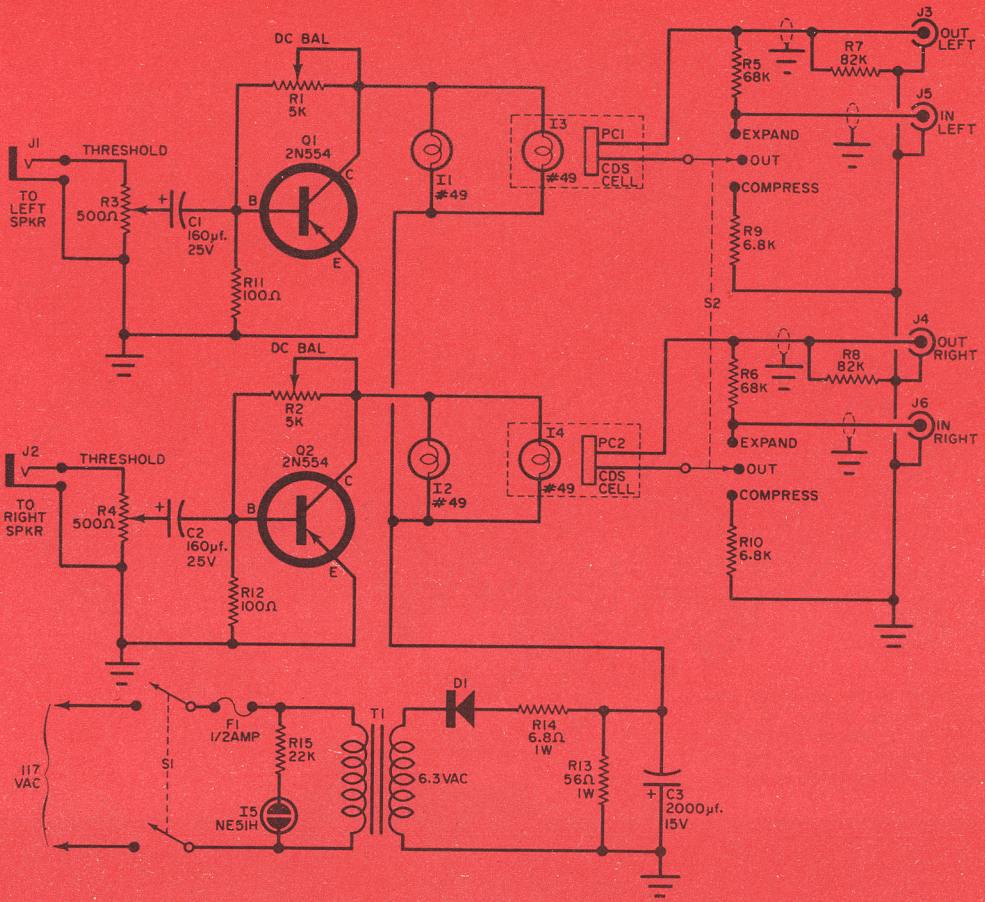
Since automatic volume compression is used to some extent in all commercial recording and broadcasting, volume expansion offers the audiophile an easy way to restore dynamic realism to a broadcast or to a tape or disc recording. On the other hand, the volume compression of which this unit is capable will be useful for those who want to listen to background music or who want to listen to the hi-fi without disturbing their neighbors.

How It Works. The idea of using a lamp and cadmium sulphide photocell in a feedback circuit is not new, but few experimenters have had the chance to try this circuit in their hi-fi systems. Use of transistor amplifiers—unique with this unit—allows expansion and compression at relatively low listening levels.

Output voltage at the speaker terminals of each stereo channel is used to drive a transistor amplifier/limiter which, in turn, controls the intensity of a lamp. The intensity of the lamp causes the resistance of a cadmium sulphide photocell to change. The CdS cell is switched in a voltage divider to either aid or retard the input voltage to the amplifier.

Since the input impedance of the transistor amplifiers is high compared to the impedance of the speakers, connecting the unit to the speaker terminals has virtually no effect on speaker performance. With the d.c. balance controls (*R1* and *R2*) adjusted so the lamps just go out with *no* audio at the speakers, a slight voltage input at the bases of *Q1* and *Q2* will fire the transistors and the lamps will begin to glow. The lamps will glow brighter as higher voltage is applied to the point where the transistors begin to saturate. The amplifiers act as limiters at this point—since a higher input will not increase output—preventing the bulbs from burning out.

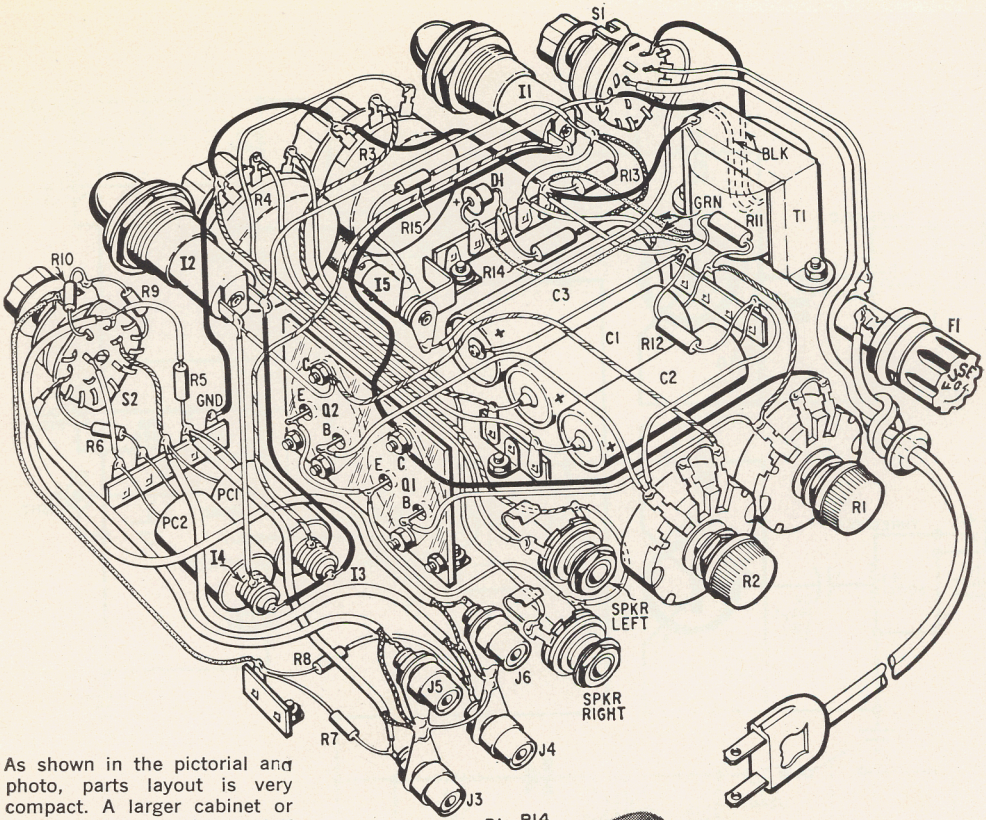
Photocells *PC1* and *PC2* are placed next to lamps *I1* and *I2* respectively, and vary in resistance from almost infinity when the lamps are dark to a few hundred ohms when they are brightly lighted. For volume expansion, the photocells are switched into the part of a voltage divider circuit in series with the audio source (tuner, phono cartridge, etc.) and the audio amplifier. Resistors *R5* and *R7* in the left channel, and *R8* and *R6* in the right channel, are selected



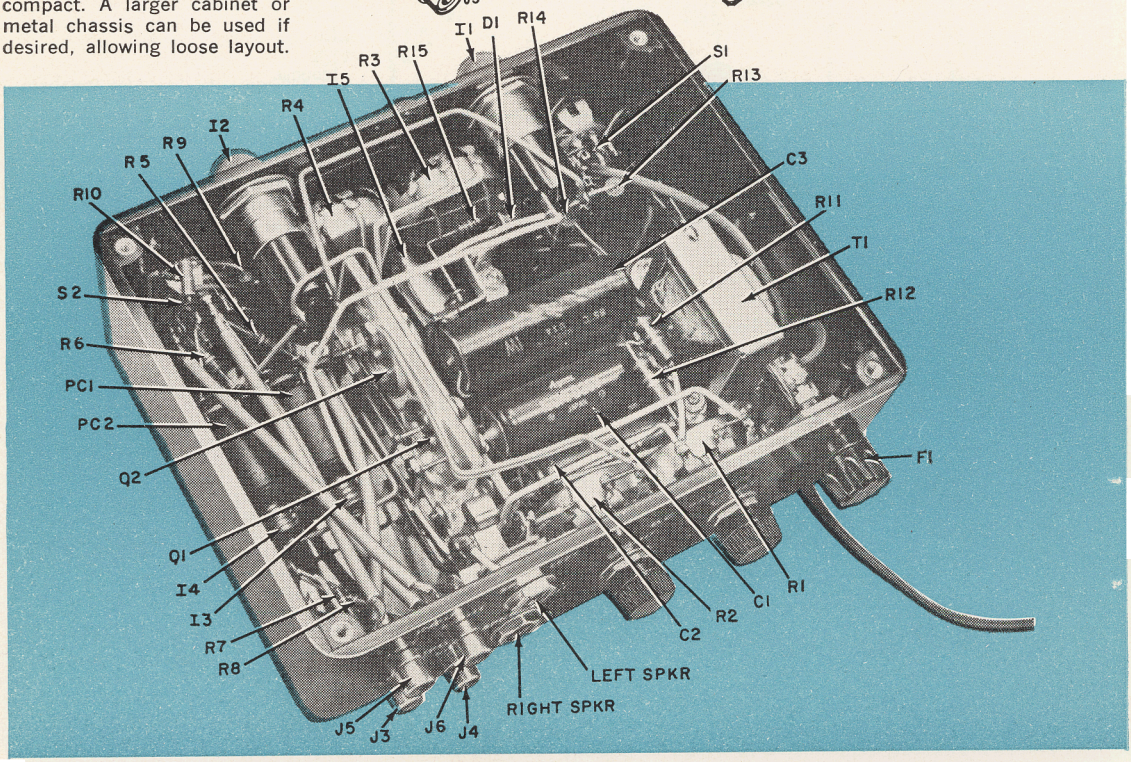
Simple circuit is duplicated for each channel. Basically, it consists of a transistor amplifier that drives a pilot bulb. Photocell for each channel is in a voltage divider circuit which changes value as the light falling on the cell changes.

PARTS LIST

C1, C2—160-μf., 25-volt electrolytic capacitor
C3—2000-μf., 15-volt electrolytic capacitor
D1—200-PIV, 750-ma. "top hat" silicon diode
F1—½-ampere fuse, type 3AG
I1, I2, I3, I4—#49 pilot lamp (GE)
I5—NE-51H neon bulb
J1, J2—Standard open-circuit phone jack (for speaker connections)
J3, J4, J5, J6—Phono pin jack (single mounting hole type)
PC1, PC2—Cadmium sulphide photocell (Lafayette MS-922 or equivalent
Q1, Q2—2N554 power transistor (Motorola) or equivalent
R1, R2—5000-ohm, 4-watt wire-wound potentiometer
R3, R4—500-ohm, 4-watt wire-wound potentiometer
R5, R6—68,000-ohm, ½-watt, 5% resistor
R7, R8—82,000-ohm, ½-watt, 5% resistor
R9, R10—6800-ohm, ½-watt, 5% resistor
R11, R12—100-ohm, 1-watt, 5% resistor
R13—56-ohm, 1-watt, 10% resistor
R14—6.8-ohm, 1-watt, 10% resistor
R15—22,000-ohm, ½-watt, 10% resistor
S1, S2—4-pole, 3-position rotary switch (Lafayette SW-30 or equivalent)
T1—Filament transformer, 6.3 volts @ 1 ampere
1—Bakelite cabinet (Lafayette MS-218, 2¼" x 5¼" x 6¾", or similar)
1—Panel for cabinet above (Lafayette MS-219)
2—Panel lamp assemblies for I1 and I2 (Dialco 930 series less resistor or equivalent)
1—Bayonet-type bulb holder for I5
1—Fuse holder for 3AG fuse
1—Length of polystyrene tubing, ¾" o.d., ⅝" i.d. (Lafayette P-475 or equivalent)
1—⅛" polystyrene sheet cut to 1¾" x 2¾" for mounting Q1 and Q2
Misc.—Rubber grommets, terminal strips, 6-32 x ¼" hardware, knobs, wire, shielded cable, a.c. line cord, small brackets for mounting Q1-Q2 mounting board, cement, tape, plastic lens for I5, etc.



As shown in the pictorial and photo, parts layout is very compact. A larger cabinet or metal chassis can be used if desired, allowing loose layout.



to give the desired amount of expansion —about 6 db in this case—as the resistance of *PC1* and *PC2* changes. Voltage relationships for expansion can easily be seen in the curve below. With the unit in the "out" position (*PC1* and *PC2* out of the circuit), any increase in audio input results in an equal increase in output as shown by the straight-line "out" curve.

In the "expand" position, a small increase in the input causes a large increase in output, and this *unequal* change in voltages is where expansion occurs. Did we get something for nothing? No, because the output was *6* db less than the input to start with (*6* db is the "line" or insertion loss of the unit), but the amplifier doesn't know this. On "expand," it sees the output only as a fast rising voltage.

For compression, *PC1* and *PC2* are switched into voltage dividers that now include *R9* and *R10* as well as *R5* and *R7* and *R6* and *R8*. Here, *PC1* and *PC2* are connected in parallel across the audio source in combination with *R9* and *R10* respectively. As shown by the "compress" curve below, a large increase in input results in a small increase in output. This unequal change is where compression occurs, to a maximum of 15 db. The amplifier now sees the output as a slowly rising voltage.

The amount of expansion is determined by the size of *R5* with respect to *R7*, and the size of *R6* with respect to *R8*. If *R5* and *R6* are made larger, more expansion may be obtained; if they are made smaller, less expansion will result. On "compress," smaller values for *R9* and *R10* will give more compression; larger values will give less.

Construction. Although a metal chassis can be used for the compressor-expander, a Bakelite instrument case was selected for ease of construction—it can be drilled and filed much like wood—and compactness. Place drafting tape on the front and rear of the case and use a pencil to locate holes to be drilled. Larger holes should be filed or reamed as large drills can cause chips around the hole being cut.

Mount the components using lock washers on the inside to prevent slippage on the smooth Bakelite. The power transistors do not require a heat sink in this application and are mounted on a piece of clear polystyrene. If transistors *Q1* and *Q2* are mounted on a metal

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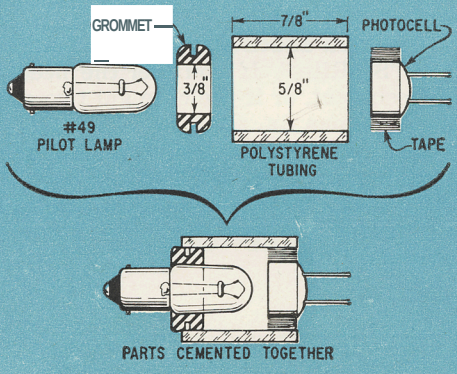
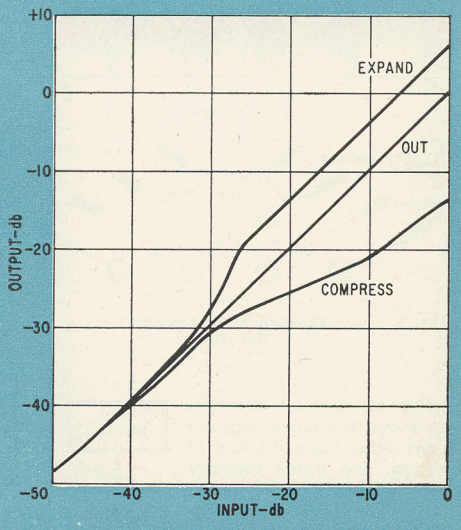


Photocell-pilot lamp assemblies—one for each channel—are constructed as detailed here (see text).



Hirsch-Houck laboratory curve shows 6 db expansion and a maximum of 15 db compression for P.E. unit.

Hi-Fi Compressor-Expander

(Continued from page **45**)

chassis, insulation must be used between them and the chassis.

Assembly of the two photocell-lamp units is easy. As shown on page **45,** cut a 7/8″ length of 5/8″-i.d. polystyrene tubing for each. Push a **#49** lamp into a 3/8″ grommet and insert the grommet and bulb into one end of the tube. Wrap 1/4″ wide tape around each photocell, using enough so they will fit smoothly in the ends of the tubes opposite the bulbs. Cement each assembly in place. Both of the assemblies should be painted black so that external light won't affect the resistance of the photocells. To make sure they are light-tight, measure the resistance of the photocell-lamp assemblies in normal reading light—if it's less than one megohm, check for leaks. Caulking compound is a good material for sealing leaks around the bulbs and photocells.

Wiring the Unit. Two separate grounding systems are used in the compressor-expander to avoid possible hum loops in the amplifier to be used with it. The speaker ground leads and power supply ground form one system; the shielded leads for the input-output circuit and photocell section form the other system.

Wiring is straightforward. Use different colors of wire for leads associated with the left and right channels to make checking the circuit easy; use shielded wire for the input-output circuit connections. Polarity of *D1* and *C1*, *C2* and ***C3*** must be observed. Resistors associated with the input-output circuit should be accessible as you may want to experiment with the amount of expansion and compression in the future. As finishing touches, add rubber feet to the cabinet, and label the controls with decals.

Hookup and Final Adjustments. Connect the compressor-expander into your stereo system as shown in the drawing below. The amplifier input impedance should range between **50,000** ohms and **1** megohm. The transistor portion of the circuit must be connected to the power amplifier speaker terminals ; be sure to connect the ground of the speaker terminals to the ground of the transistor circuit. In addition to the possible compressor-expander hookups shown here, the unit may also be connected between the output of a preamplifier and the input of the power amplifier.

To use the compressor-expander, turn it on and set the amplifier volume control to zero. Adjust the d.c. balance controls (*R1* and RZ at the rear of the case) so the corresponding front panel lamps, *I1* and ZZ, just go out. Next, set the front-panel threshold controls, ***R3*** and *R4*, to maximum clockwise and turn up the amplifier volume to a normal listening level. Expansion or compression can then be selected.

Optimum setting of the threshold controls has been found by the author to vary from one type of program material to another. On the average, they are set to produce full illumination on the loud parts and no illumination on the soft parts.

Needless to say, the unit will greatly enhance your listening pleasure. —30—

HIRSCH-HOUCK REPORT

The 6 db expansion was definitely more pleasing than the 8.5 db of a comparison commercial unit. The compression was more than adequate. Under conditions of compression or expansion there was no high-frequency loss. The unit was easy to install and adjust, and did all that could be expected. Well planned and constructed . . .

Simply connect compressor-expander between audio source and amplifier.