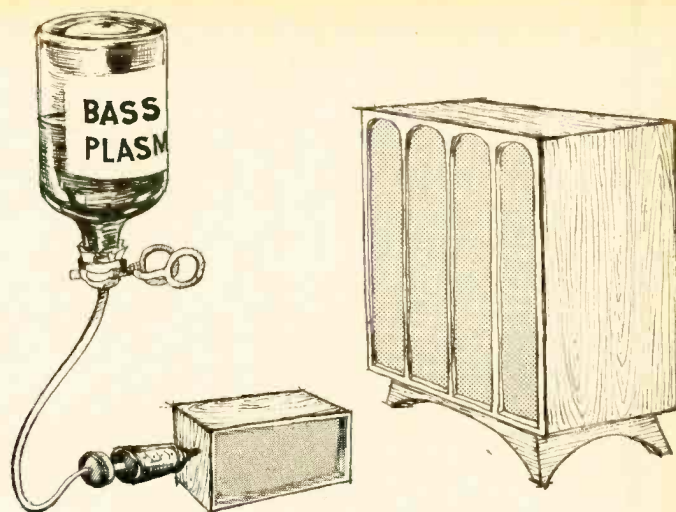


# Bass Transfusion for Little Speakers



**BILL YEAGER and ROGER HULL**

Proper shaping of the low-frequency spectrum to conform to Fletcher-Munson can put the bass range in proper listening perspective. One can achieve this by means of experimenting with appropriate low-pass filters and T-pads, or simply by use of this device.

Loudspeaker authorities agree that it is the inherent lack of bass which prevents a small speaker enclosure from producing that full rich sound. On the other hand, some home music listeners object that large speaker cabinets occupy too much floor space. The basic problem is one of: Less Space or Less Bass?

Although the high-fidelity purists all favor the realistic sound they gain over the living space they lose, many other music enthusiasts have reluctantly accepted less fidelity from a pair of so-called "bookshelf" speakers simply because their listening area would not

permit installation of larger speaker enclosures.

In other homes, it was a wifely influence which selected an all-inclusive piece of furniture known as a stereo console—usually complete with tuners (AM-FM Multiplex), stereo amplifiers, a record changer, a tape deck, a television set, shelf for record storage, compartments for extra tapes, microphones and other accessories, and, almost accidentally, a couple of cubic feet left over at the ends to serve as speaker enclosures. But, the console conformed with the decor regardless of its acoustical qualities—or lack thereof. As a result, the living room now is graced with a fancy Falsetto Provincial or a gleaming Clarion Modern; visually healthy and handsome, but suffering from a deficiency in its "bass-ic" metabolism.

Yet within that missing low-frequency range are the fundamentals of most music. The first three or four octaves encompass the low tones of the organ, piano, harp, bass viol and drums, plus those of brass and woodwind instruments. Without these bass notes, reproduced sound will lack the balance and the basic harmonics necessary for

a sense of "presence" in music . . . if the original program material possessed it. A recording of a piccolo solo, for example, suffers very little from a lack of adequate bass.

The ability of a speaker to reproduce bass is determined by its resonant frequency; that frequency at which the voice coil, speaker cone and its suspension mechanism vibrate as a single unit. Both large and small speakers can be constructed with a very low free-air resonance; down to 25 or even 20 cycles. When a speaker is activated, its vibrations create sound waves to the rear of the cone as well as to the front. In a small speaker enclosure the stiffness of the air trapped behind the speaker tends to restrict these waves and thereby inhibit the cone movement. This can cause the resonant frequency to rise as much as an entire octave. Unfortunately, below the resonant frequency of a speaker, its response level falls off about 12 decibels per octave. Another factor affecting the problem of bass response is the character of the human auditory sense. Back in the 1930's, extensive research on acoustics and hearing was done by Fletcher and Munson. They found that there is a fading in the ability of the human ear to hear the lower frequencies; a fading which starts at about 300 cycles at normal listening levels. Therefore, the apparent loudness of a tone depends not only on its intensity, but also on its frequency. As the frequency lowers, its sound level seems to decrease. This decrease must be compensated if the listener is to hear a realistic reproduction of sound.

On most home amplifiers, the bass boost control hinges at around 1000 cycles. Attempts to compensate for a bass deficiency in the speakers by use of the bass boost control will affect the



Fig. 1. Altec-Lansing Bass Energizer.

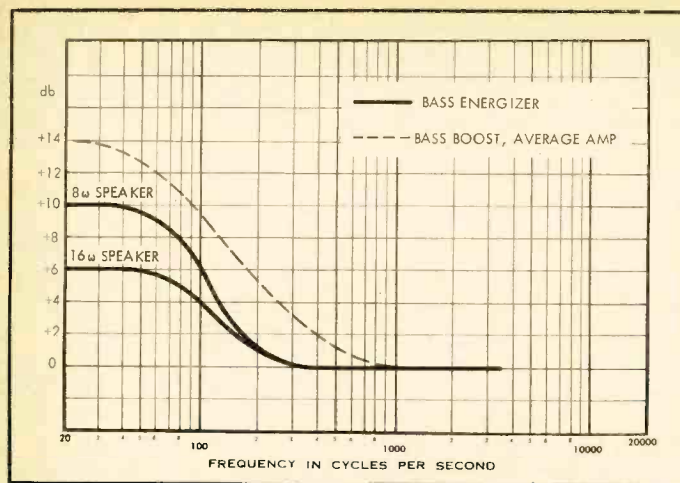


Fig. 2. Bass energizer response compared with the bass boost of average amplifier.

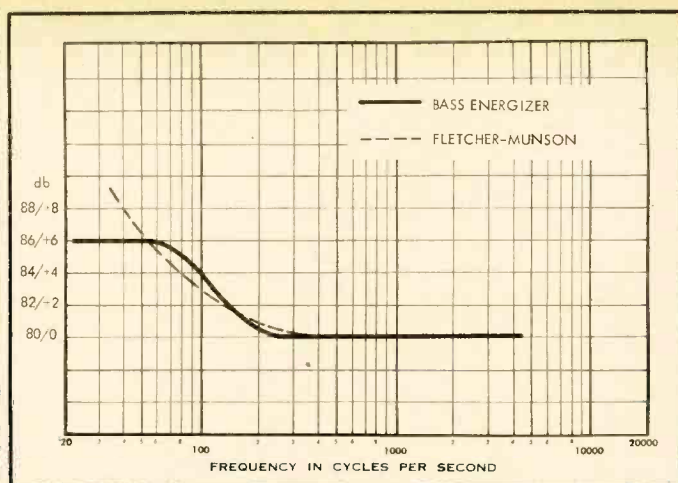


Fig. 3. Bass energizer response used with 16-ohm speakers compared to Fletcher-Munson curve for 80 db.

important mid-frequency area. If there is too much emphasis on tones within this range, a "tinny" sound will result. This is particularly true if the system uses small speakers in which the mid-range cannot be boosted without doing serious damage to the fidelity of the reproduction.

In order for a woofer in a small enclosure to approach the bass response achieved by one in a larger cabinet, there must be a gain increase in the lower frequencies, but *only* in the lower frequencies. Most attempts to solve the problem of weak bass in small bookshelf size speakers have involved some form of an amplifier. To accomplish the same thing without additional amplification devices, Mr. Alexis Badmaieff, Altec's Chief Engineer of Acoustic-Transducers, has developed Altec's new 100A Bass Energizer.

The Bass Energizer is a passive device which requires no additional electrical power. Connected between the amplifier output and the speaker input, it helps compensate for low-frequency deficiency in a speaker by providing a comparative increase in the bass response. This increase becomes effective at approximately 150 cycles and builds to full efficiency from 60 cycles on down to the cut-off of the speaker's capability. In effect, the bass energizer acts as an extreme low-pass filter which increases the fundamental bass without affecting the response of the mid- or high-frequency range (see Fig. 2).

This increase in bass level response approximates the Fletcher-Munson curve shown in Fig. 3. Assuming that the average home music enthusiast drives his equipment at a level somewhere close to 80 decibels—that is, a sound level approaching that of a mid-point seat in a concert hall (more than an atmospheric serenade but less than window shattering)—the bass compen-

sation provided by the energizer remains within  $\pm 1$  decibel of the Fletcher-Munson curve down to about 40 cycles.

Among the tests run on the bass energizer was one which compared a small infinite baffle enclosure containing an 8-inch woofer to a large bass reflex cabinet containing a 15-inch woofer. The small enclosure was equipped with an energizer, but the larger cabinet was not. On the basis of low-frequency response only, most listeners found it difficult to determine which speaker was being driven. Although the small enclosure was not the equal of the big speaker, the energizer did accentuate its bass response until it approached that of the larger cabinet.

Similar tests conducted with other speakers of various types and sizes indicated an increased bass intensity averaging from +6 to +10 decibels in every case, regardless of the size or type of speaker or of its enclosure.

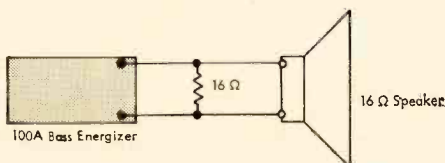


Fig. 4. Shunting a 16-ohm speaker for increased bass boost.

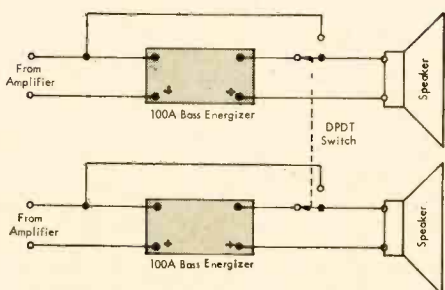


Fig. 5. Switching setup for bypassing energizer.

Another aspect of the sound reproduction problem which the bass energizer helps correct is that of "scale distortion." When music is reproduced through an amplifier with a flat frequency response and is fed to speakers at a level approaching the same degree of loudness it had in the studio, the tonal balance of the reproduction will approximate the original sound. In the recording studio, however, the level of the original orchestra may reach 100 decibels and more, a level rarely reached by a listener at home. When the reproduced sound level is less than that of the original source, scale distortion occurs; primarily because the bass is weak compared to the mid-range frequencies. At lower listening levels, orchestra and organ music will lose its luster and become flimsy and dull. To correct such distortion and to regain the tonal balance and natural qualities of such music when it is played at background level requires (once again) an increase in the bass end of the sound spectrum.

At low gain levels, the bass energizer is at its best. Scale distortion is prevented and musical "presence" is attained without cranking up the bass boost on the amplifier to its maximum position; an increase which will raise the level of all frequencies below 1000 cycles. For the owner of a stereo rig who prefers "tunes-to-talk-over", the bass energizer provides a new fidelity of sound. For the critical listener who also is an apartment dweller, it is almost a must.

The energizer is designed primarily for use with efficient speakers; speakers which use a minimum of amplifier power to reproduce the entire audio range without perceptible distortion. Technically, the efficiency of a speaker is determined by the ratio of its output

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## LETTERS

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enthused about this equipment. It is performing so well that another one is in the planning stages now, with four separate amplifiers feeding two sets of heads on an adjustable scale to give a reverberation effect on playback. Maybe even a switching arrangement to several heads or variable (switched) delay. Incidentally, I have tried a reverberation unit (K-10) between

the amp and pre-amp on playback and the results are excellent.

DWIGHT L. CHAMBERS  
3718 Narragansett Avenue  
San Diego, California 92107

(That new unit sounds fascinating, perhaps Mr. Chambers will submit it for publication and share his ideas with the rest of us. Ed.)

## CALCULUS MADE DIFFICULT

(from page 42)

Since  $d$  is indefinitely small,  $d^2$  is awfully small, and  $d^2 x^2$  vanishes.  $2x \cdot dx$  doesn't exactly vanish; it just sort of chickens out, because if  $d$  is as small as all that, then no matter what you multiply it by you won't get much out of it. This leaves you with

$x^2$ , Eq. (12)

and since the same applies to  $(r + dr)^2$ , we have also

$r^2$ , Eq. (13)

This is what happens to the series-resonant circuit in Fig. 1(A). But since  $r_1$  is a very large resistance, then  $r_1^2$  is awfully large, at least, compared to  $r_2$ . We have, then

$r_1 \gg \gg \gg r_2$ , Eq. (14)

which means that  $r_1$  has an awful lot of ohms. Therefore, its shunting effect on  $r_2$  is negligible.  $r_2$ , on the other hand,

has a very small resistance compared with  $r_1$ , because if Eq. 14 is correct, then  $r_2 \ll \ll \ll r_1$  Eq. (15) by the Law of the Reciprocation of Relative Quantities.

$r_2$ , then, has almost no ohms to speak of, and may be regarded as a virtual short circuit. However, a glance at Fig. 1(A) tells us that  $L_2 C_1$  is a parallel impedance having an infinite resistance at resonance. Since this is virtually an open circuit, the short circuit  $r_2$  isn't short-circuiting anything, and so may be disregarded.

Figure (B) shows the equivalent circuit of Fig. 1(A) after all the negligible values have chickened out. Its advantage from a standpoint of wiring and production is obvious.

It's all in knowing how. Æ

## BASS TRANSFUSION

(from page 22)

sound pressure level to its electrical input power level. Although the experts may tend to differ slightly, generally they agree that an efficient speaker will produce a sound pressure level of approximately 90 to 92 decibels and more from a distance of 4 feet with an input of 1 watt. Not so technically, the owner of the usual high-fidelity system probably has an "efficient" speaker if it will reproduce good quality sound at normal to high listening levels with the amplifier gain control set to only about 1/4 to 1/3 of its maximum position.

A 16-ohm device, the energizer has an insertion loss of 6 decibels from 150 cycles up when it is used with a 16-ohm speaker, and a loss of 10 decibels when attached to 8-ohm speakers. This, in effect, is a relative increase of from 6 to 10 decibels in the frequency range below 150 cycles. This 10 decibel increase explains how, at relative sound

pressure levels, an 8-ohm speaker in a small enclosure can imitate the bass response of a speaker mounted in a much larger cabinet. It is possible to provide a 16-ohm speaker with the full 10 decibel rise in low-frequency response by shunting the speaker input with a 16-ohm wire-wound resistor as indicated in Fig. 4.

Because the bass energizer requires an increase in amplifier power, it should not be used with low efficiency speakers unless they are driven by an amplifier with sufficient output to overcome the insertion loss. A more than sufficient listening level may be achieved with a relatively small 15- or 20-watt power amplifier when the energizer is used with efficient speakers. If used with an amplifier which is capable of 50 to 75 watts or more, the energizer will produce satisfactory results with inefficient speakers. However, although tests

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conducted with an inefficient speaker driven by a 25-watt power amplifier indicated an improvement in the low frequencies, it also made it apparent that the output power capability could leave a true hi-fi bug a bit frustrated.

Many stereo addicts are unaware of the potential destructive power involved when a large power amplifier is used with efficient speakers. Such a combination can "blow out" the speakers if excessive power is applied to them. In addition to its major function, the installation of a bass energizer in such a system permits it to act as a protective device also. With an energizer installed, a 16-ohm, 35-watt rated speaker may be coupled to a 70-watt power amplifier with absolute safety. Twice as much protection is provided when a 16-ohm speaker is connected as indicated in Fig. 4, or when an 8-ohm speaker is used.

Some listeners may prefer a dual purpose stereo system which may be used at both low (background music) and high (neighbor annoying levels. The ad-

dition of a simple DPDT (double pole, double throw) switch allows the energizers to be switched into and out of the circuits as the need arises. Fig. 5 shows the installation circuit for connecting this switch. The inclusion of the switch also provides a quick and simple means of demonstrating the effectiveness of the energizer.

Physically, the unit is only 5¼-inches in length (including mounting ears), 2⅞-inches in width, and 2⅞-inches in height (including terminals); small enough to be mounted almost anywhere. It will fit on the back of the speaker cabinet or it may be placed within the enclosure or the equipment cabinet. If it is to be switched in and out of the system, placement of the unit and the switch within the equipment cabinet will simplify wiring.

Although it cannot replace the perfect bass response of a carefully designed large speaker system, the Altec Bass Energizer can provide a healthy bass transfusion for any little bookshelf speaker.

## AUDIO ETC

(from page 14)

into the home system? Plenty! Might cause a number of healthy explosions.

### Integration

TV tape, as we see, will first of all "blend" right into the home tape recorder. Same tape, same deck, sharing audio electronics and drive mechanisms. Seems likely, anyhow. That's something! Maybe not all at once but, in the end, inevitably. Then you'll be able to record "off the air," on your tape deck, all the mono or stereo audio you want, plus any old video you may see on your "tuner." Live shows. And, of course (above the law?) all sorts of commercial movies—suddenly turned into repeatable home movies. (Get busy, you copyright lawyers.) Take down the Beethoven Ninth Symphony in stereo. Or the Beethoven Ninth in a TV spectacular. Button A or Button B. But is this the end? Far from it.

Along comes the TV camera (in home form), the video "mike" for your recorder. And presto—you have home "movies" on tape. You can play them back through your TV set. But, of course, they won't work on your movie projector. Too bad. That's a missing link.

It won't be for long. Somebody, natch, will develop a new gadget for you, a projection TV attachment for the home movie screen, out of your video recorder. Easy.

And, quick as a flash, the reverse as well! Maybe even part of the same package. An adaptor for your video "mike," (the camera) so you can "play" your film movies directly through the video circuits of your recorder and into your TV set. Nothing to it. They've been doing this for years in the TV studios.

### Eraseable Home Movies?

Link after link, tie-in upon tie-in! How about portable TV recording? Well, that is a bit of a way off. But still—? Could it offer redundant competition with the home movie camera, pitting tape against film?

A TV camera, alas, has to be hitched to a TV recorder. And until we develop something weighing rather less than 95 pounds, there won't be any home TV-in-the-field. Not until, that is, we develop a micro-recorder that will reel magnetic TV tape inside the space now taken by a roll of film in a movie camera. Who knows? Could be! Just turn in your old obsolete film camera and get back a new one that looks the same, only its battery-pack runs tape, not film, and you can *erase* your pictures and start over again if you don't like them. Wow! Is *that* an idea! And you can see the pictures seconds after you make them, too. Better get the Poloroid people in on this one . . .