

HIGH FIDELITY'S

Buying Guide to Speaker Systems

ICD 08402

\$1.50

-1976 Edition

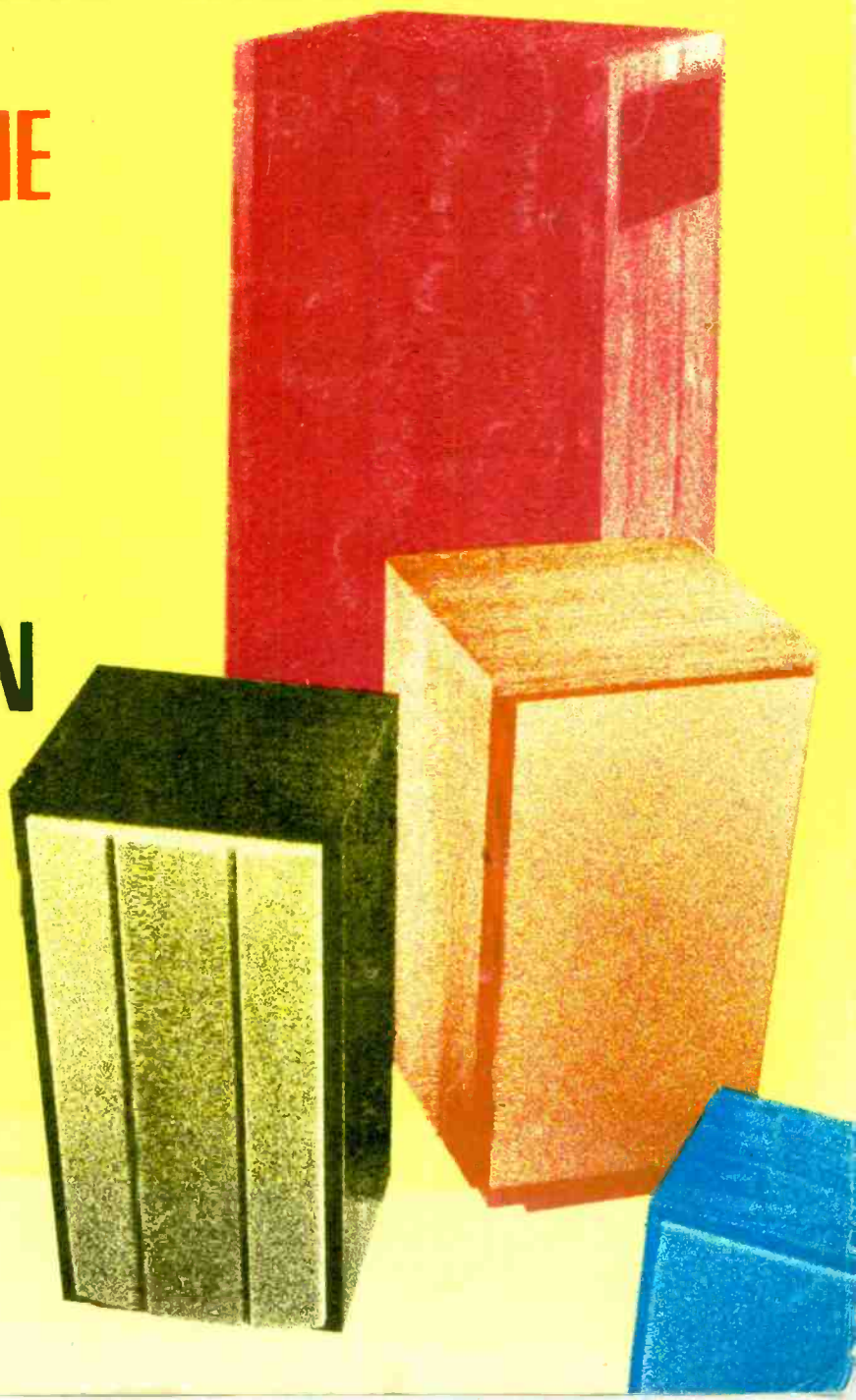
**FACTS AND FIGURES ON
OVER 400 CURRENT MODELS**

**HOW TO PICK THE
BEST SPEAKER**

- For your system
- For your room
- For your budget

**NEW TRENDS IN
SPEAKER DESIGN**

**HOW TO
IMPROVE
SPEAKER
PERFORMANCE**



Now, from JBL, something you've probably never heard before: the other half of the music.

(JBL has perfected an entirely new sound system. The most astonishing part is a new high frequency transducer that can fill a room with the high half of sound. It works – well, it works like a nozzle.)

We're going to talk about acoustics and harmonics and all sorts of heavy stuff for the next minute or two. We'll try to do it with merciful brevity. But at the end we're going to unveil a new \$426 loudspeaker called Jubal.



For that kind of money, you're entitled to know what you're getting into.

First, music.

Half the music you hear is in the low and midrange of sound. "Fundamental tones," they're called: the human voice, a piano, a guitar, a violin, a trumpet, whatever. That's where you hear the basic shape and form of sound.

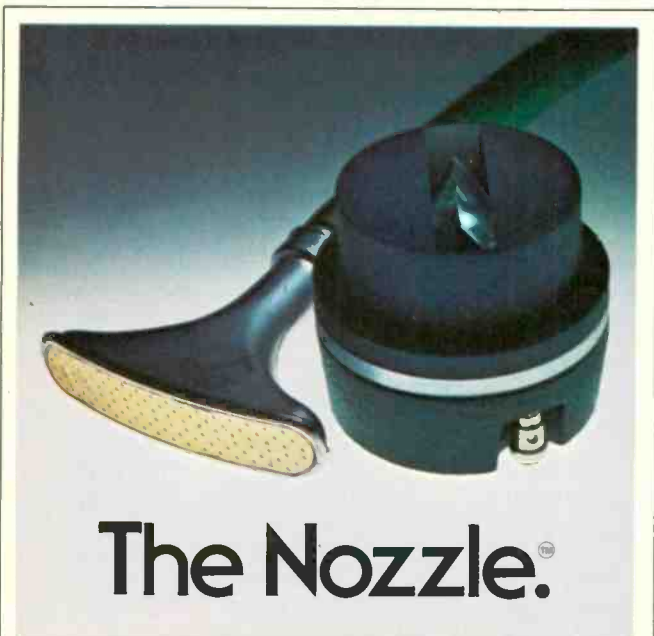
But the character of music, the music of music – overtones, onset tones, all the harmonic shading and texture and subtlety are hidden in the highs. (Without them you couldn't tell a flute from a trumpet from a piano.)

Next, the hard stuff.

Any good sound system is designed to disperse sound throughout the room. What you hear and feel is direct and reflected sound. Together they create ambient sound, the sense of being in the middle of something.

Now, as long as the music is in the low and midrange, the

traditional tweeter will spread it around. But as the tones go higher, the tweeter narrows its range. There's a pea-shooter effect. You have to stand directly in front of the speaker to hear the high highs. They never get to the rest of the room.



It's formal name is the JBL 077 Ultra High Frequency Transducer.

It was developed because the world of recording and listening is still very square. Sound studios, auditoriums and living rooms are box-like.

But sound is conical, circular, radial – the pebble in the pond.

The Nozzle® accepts enormous amounts of high frequency power and disperses it into a near-perfect horizontal pattern.

The result? Pure, bright, transparent, distortion-free high frequency tones throughout the room.

Nice.

Enough words. Go hear the music. Take a favorite tape or record – something you know by heart – and ask your JBL dealer to hook it up to Jubal.

If you think Jubal sounds like something special, friend, you don't know the half of it.



The best way to pick a speaker is with your eyes open.

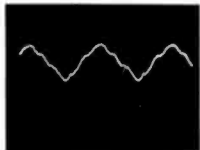
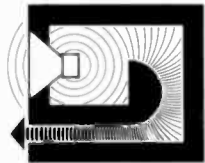
All speakers are not alike.

Even speakers that appear similar can sound very different.

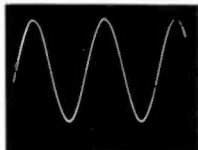
For example, when you compare a B·I·C VENTURI™ speaker system with others, you'll be astonished at how much more sound it delivers...even from a modest amplifier:

Behind the speaker grille you'll see the Venturi name over a cabinet slot that looks like a bass reflex "port" but isn't. "Bass reflex" speakers, whether they use slots, holes, or shelves, merely resonate an enclosure to a single frequency, achieving bass emphasis only at that one point.

The opening you see on a B·I·C VENTURI cabinet is the terminus of the Venturi path inside the enclosure (U.S. Pat. 3892288). It works as an acoustic transformer to produce bass energy as much as 140 times greater than would otherwise be achievable from a woofer alone in the same size cabinet.



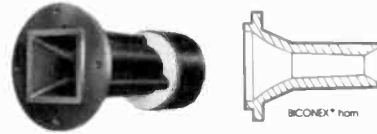
A—Shows output of low frequency driver when driven at a freq. of 22 Hz. Sound pressure reading, 90 dB. Note poor wave form.



B—Output of B·I·C VENTURI coupled duct. (under the same conditions as Fig. A) Sound pressure reading 111.5 dB (140 times more output than Fig. A) Note non-distorted appearance.

Oscilloscope photos reveal that a B·I·C VENTURI speaker actually eliminates harmonic distortion from reproduced tones, literally purifying the sound and resulting in clean, tight and extended reproduction. That you can hear!

Notice the square-shaped mouth of the exclusive BICONEX™ midrange horn (pat. pend.). This unit is exceptionally efficient. It has remarkably smooth, uncolored response because of its unique conical/exponential



flare. It is made of an inert substance to avoid "ringing" and spurious resonances. But, equally important, it provides wide-angle dispersal of sound in both horizontal and vertical planes, making speaker positioning non-critical. There is a super tweeter that operates in only the last octave for accurate musical timbre.

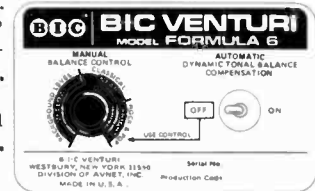
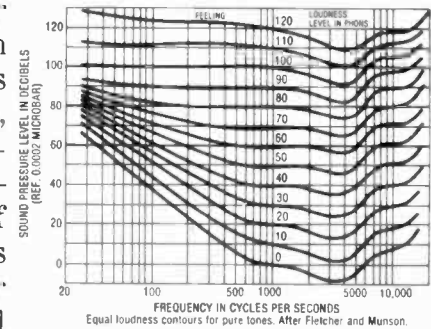


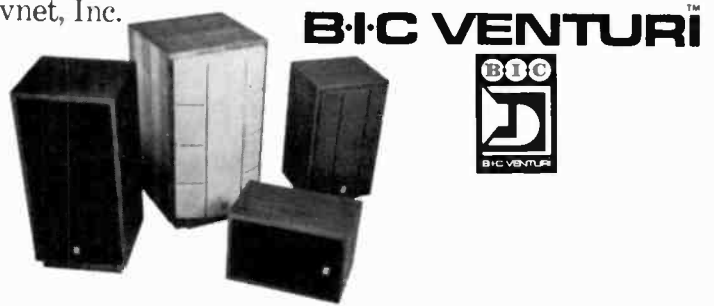
Fig. C

Even the control panel on the front of the baffle board is a surprise. It controls an exclusive built-in device (pat. pend.) which compensates for the normal loss in hearing of bass and treble tones, (figure C) at various listening levels. Regardless of amplifier loudness settings, you hear all the music, all the time. This is accomplished automatically with the switch in the "on" position, or, you can adjust tonal balance manually for the type of music you play or the kind of sound you prefer:



There's really much more to B·I·C VENTURI speakers such as how they compare with other design types in performance, and the way they *function* in a high fidelity system.

If you want to read some interesting and informative literature, ask your franchised B·I·C VENTURI dealer for a copy of our new 20-page consumer guide to loud-speaker performance, or write to us: B·I·C VENTURI, Westbury, N.Y. 11590. Div. of Avnet, Inc.



CIRCLE 6 ON READER-SERVICE CARD

BUYING GUIDE TO SPEAKER SYSTEMS

HIGH FIDELITY'S Buying Guide to Speaker Systems —1976 Edition

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All speakers make sound, but some make it differently than others.

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HOW TO INSTALL AND LOCATE YOUR SPEAKERS

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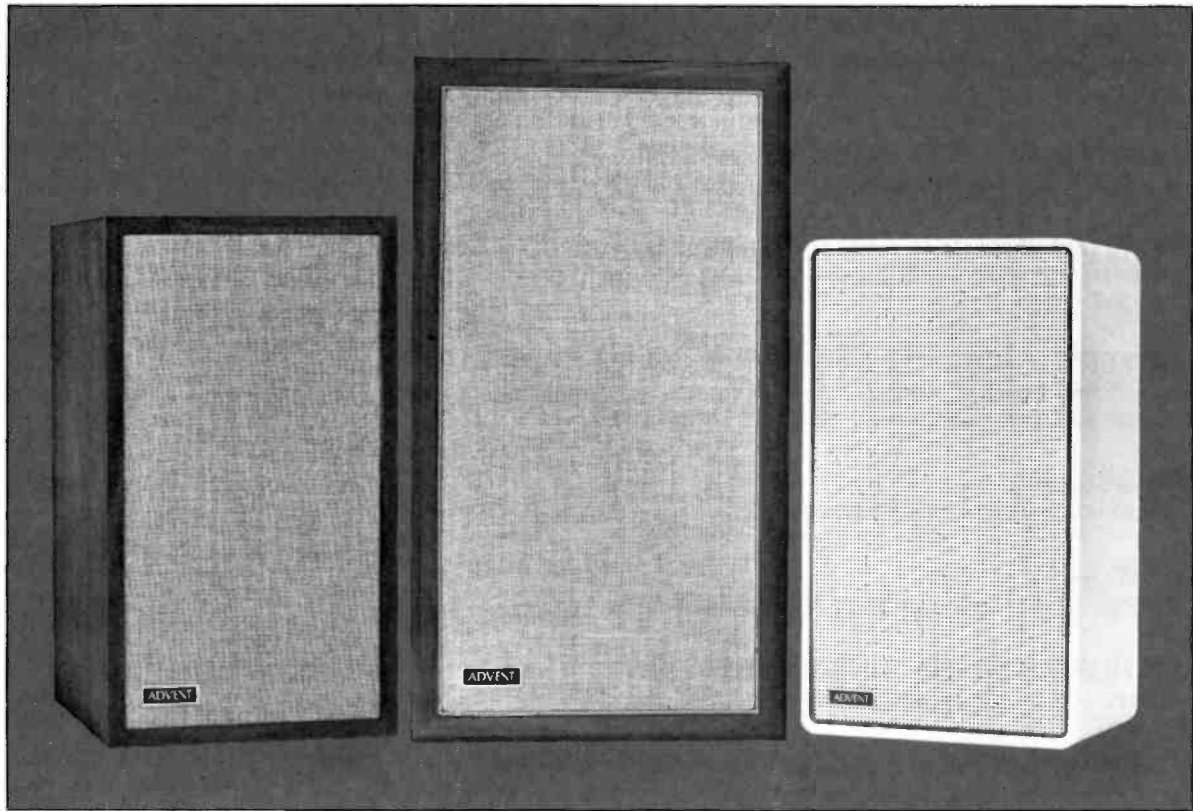
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The Three Advent Speakers



When products become best-sellers largely on the strength of word-of-mouth advertising, and when people consistently go out of their way to write the company and say thanks for making them, you have reason to believe that something special is going on.

The something special is this:

The three speakers described in this ad do exactly what they are represented to do.

The Advent Loudspeaker

The original Advent was designed to compete in every audible respect with the most expensive speakers available, at a fraction—often a very small fraction—of their cost. Its useful frequency range is as wide as any speaker's, and its sound is clean, clear, and beautifully defined, with a musical balance that is satisfying not just with the best recordings or one kind of musical material, but with the whole range of music and

the various ways of recording it. Its bass response is approached by only a handful of speakers at any price, and surpassed by none.

It costs \$114 to \$141, depending on cabinet finish and where in the country it's been shipped.

The Smaller Advent Loudspeaker

The Smaller Advent was designed to do exactly what the original Advent does, at half the size and two-thirds the cost, except that it will not play quite as loud. Its range and overall sound are the same as the original (not close, but the same), and for anything short of roof-raising volume levels in really big rooms, you would be very hard-pressed to hear any difference between original and Smaller.

The Smaller Advent costs \$89 to \$94.

The Advent/2

This is the newest Advent and it sounds just like the other two except that it doesn't have the final half-octave of bass response that they do. It's designed for an absolute maximum of useful performance at lowest cost, and its own low price is made lower still by the fact that it works superbly with low-cost, low-power amplifiers and receivers. It comes in a beautiful, warm-white molded cabinet instead of the usual low-cost imitation wood finish, and since the enclosure does what a wood one does at far lower weight, it's much easier to mount on a wall or shelf.

The Advent/2 hasn't had as much time as the other Advents to get word-of-mouth going. But it will. What it does is enable people to put together a stereo system for well under \$400 that isn't a "starter" or a compromise for a tight budget, but a joy to live with ever after.

The Advent/2 costs \$74 to \$78.

To check the accuracy of the above statements, just take along your eyes and ears and (whatever shape it's in these days) your common sense to the nearest Advent dealer. We will be happy to send you his name, and literature on our speakers, if you will send us the coupon.

Thank you.

Advent Corporation
195 Albany Street, Cambridge, Mass, 02139

- Please send information on your speakers.
 Also on your Model 201 Cassette Deck.

Name _____

Address _____

City _____

State _____ Zip _____

Advent Corporation, 195 Albany Street, Cambridge, Massachusetts 02139.

Loudspeakers – Science, Art, or Both?

IF, as someone in a Huxley novel puts it, the performing of violin music is a matter of scraping horsehair across catgut, what shall we say of the reproduction of that music by a loudspeaker? Is it something like a piece of paper fluttering in an iron frame to simulate the scraping—or is it rather a technical and aesthetic miracle? We prefer to think of it as something between those two extremes, even as the very concept and design of a loudspeaker is a compromise between the possible and the ideal.

The nature of a loudspeaker is at once very simple and very complex. Of all the component parts of a sound-reproducing system, the loudspeaker is the most conspicuous visually. It is larger than any other part; and indeed some speakers occupy more space than all the other equipment combined. It also plays the most obvious role acoustically. The speaker, after all, is literally the mouthpiece of a music-reproducing system. In the audio reproduction chain there is no sound before the loudspeaker, only mechanical and electrical analogues of sound. The speaker has the demanding job of translating those replicas into actual sound. In so doing, it must behave as a passive respondent to an amplifier (which does not, or should not, produce sound as such), and yet in its passivity it must stir the unwilling air with the breath of life that is music. At best, then, a really high-fidelity (i.e., accurate) speaker is difficult to design and build, and even more difficult to evaluate. Indeed, the testing of a speaker—if done completely and correctly—becomes as much a kind of artistic critique as it is an engineering analysis. Perhaps one could sum up by saying that while a speaker is not a musical instrument it must be able to sound like any instrument, or any combination of instruments, including the human voice.

In stating what a speaker's intended function is, we have also implied the diversity of ways in which it may perform that function. For if a speaker must "sound like" music, music itself sounds different to different ears. "I like any speaker that puts me in the sixteenth row of Carnegie Hall" describes a listening taste that is different from, but no less valid than, "Give me a speaker that puts the percussion in a corner of my living room." One can disagree with these expressions of preference, but who can say that either is "right" or "wrong"? The particular quality of a specific speaker that endears it to one listener may entirely disqualify it for another listener of different musical taste.

The designers and manufacturers of speakers have very obligingly made available a variety of speakers to cater to all tastes, and in this volume we take careful and comprehensive note of this technological productivity. Here we find ourselves in the realm of the "possible." Yet—in this abundance of models as well as of sonic quality—we see a stretching toward the "ideal." The perfect speaker would be an infinitely small point in space, radiating all frequencies with equal intensity and omnidirectionally. It would be a speaker whose performance signified the repeal of the laws of inertia, or indeed the achievement of perpetual motion. On this planet and in our space-time continuum, a realization of this is not possible, but the vision of an ultimate goal is perceptible in the work of designers and engineers. Creating new designs, devising new techniques, they give us something always a little better than we have previously known; yet each new achievement mocks its maker with old problems still unsolved or new ones just revealed. Small wonder that of all the specialists in audio, those who make speakers are regarded as poets and dreamers, as much artists as artisans.

N.E.



THE INNOVATORS. BY BOSE.

The only Direct/Reflecting® loudspeaker systems.

The Bose 901, 501 and Model 301. The only speaker systems that meet the two basic requirements for preserving the qualities of live music in reproduced sound: the proper balance of reflected and direct sound for spaciousness and clarity; and flat power radiation to assure correct frequency balance and accurate reproduction of instrumental timbre in an actual listening environment.

The internationally acclaimed 901® system utilizing nine full range drivers with an active equalizer to provide the ideal balance of reflected to direct sound at all frequencies, setting the standard for lifelike music reproduction in the home.

The unconventional 501 incorporating an exceptionally linear 10" woofer and two rearward facing tweeters to furnish many of the performance advantages of the 901 system, but at substantially lower cost.

Model 301 Patents Issued and Pending

The new Model 301 offering a unique combination of features: Asymmetrical Design, a Direct Energy Control and a Dual Frequency Crossover™ network. This achieves reflected and direct sound with flat power radiation in a bookshelf enclosure, producing a sound quality that is extraordinary from so compact a speaker at so low a price.

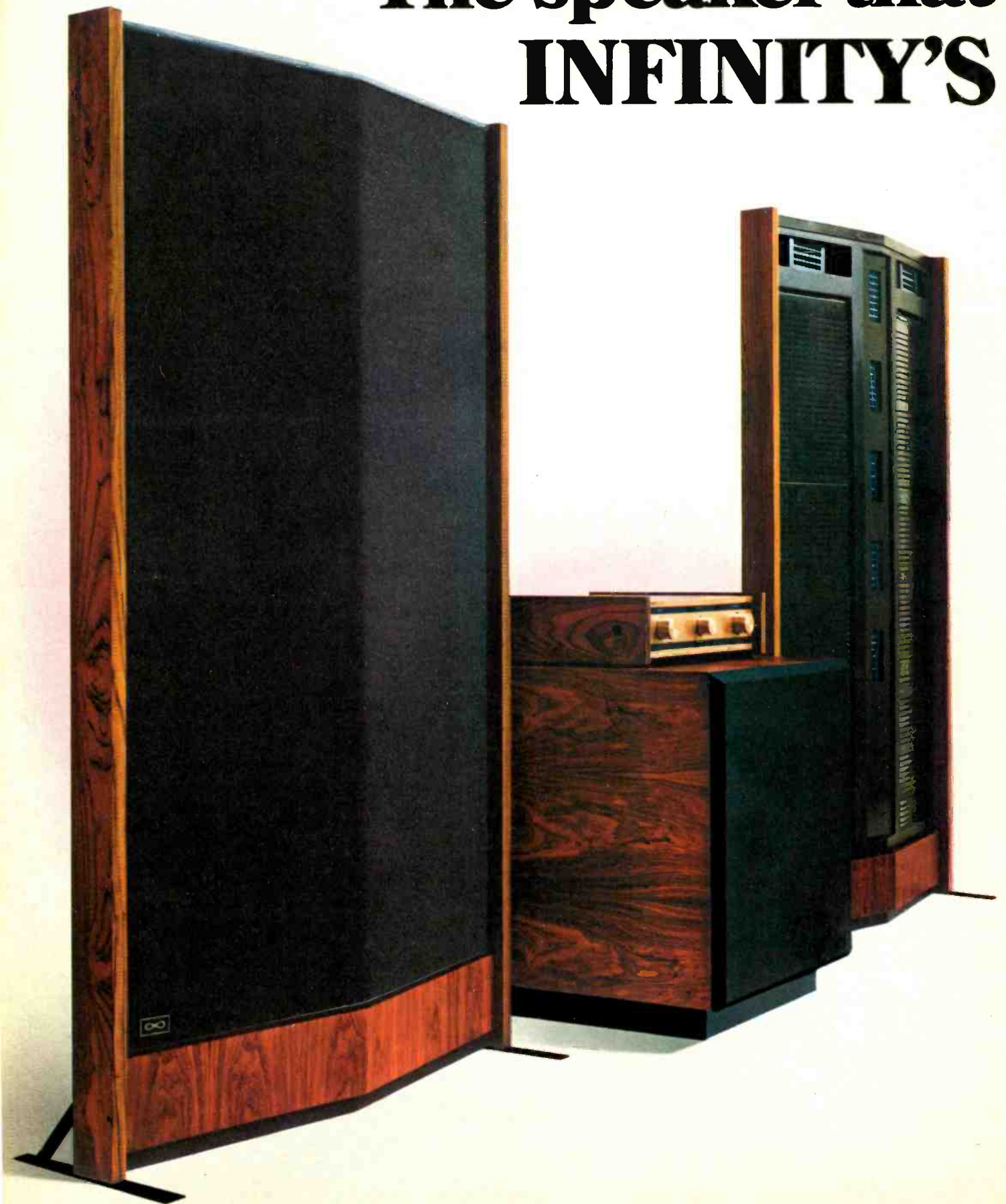
The innovative speakers. From Bose. Each unique in concept and design to provide the maximum musical enjoyment for your home. One of them will ideally meet your requirements.

Shown above, left to right, 501, 901, and Model 301. For information, write to us at room HS.

BOSE®

The Mountain, Framingham, MA 01701

Announcing
The speaker that
INFINITY'S



wasn't made to sell.

SERVO STATIK 1A

Not very long ago, before Infinity Systems was Infinity Systems, it was a small group of extremely dissatisfied, conceptually exotic, pighead-stubborn aerospace-physicist/music freaks in a garage.

Our dissatisfaction was with the sound and inherent distortion in *all* existing speakers.

Our exotic concepts promised an entire new technology of audio electronics.

And our obstinate nature made us push those Lorelei theories into a unique realization: the Servo Statik 1.

We developed the Servo Statik for one reason—to create the world's finest medium of audio reproduction, regardless of cost. For ourselves, really.

We figured we could then use this new proprietary technology primarily as a reference standard—a benchmark technology, enabling us then to create a popular-priced line of vastly superior-sounding speakers. We didn't figure people would actually line up to buy the appallingly expensive Servo Statik 1.

We were wrong.

The mystique grew. And so did Infinity.

Now we are announcing the Servo Statik 1A. Without fear of contradiction we

can state that no speaker ever made is as

distortion-free, as accurate, as capable of as wide a dynamic range and as great a frequency response as the Servo Statik 1A.

The system consists of two electrostatic screens which produce tones from 70 Hz to 40 kHz, a separate bass cube producing tones from 15 to 70 Hz and a servo bass amplifier/electronic crossover.

Its 15 Hz to 40,000 Hz power bandwidth means it produces the full sonorities of the 64 foot diapason (the largest pipe of a cathedral organ) as well as the inaudible but vitally important orchestral overtones.

Its 114 dB peak sound pressure levels means it can fully reproduce the transient peak of every section in the symphony orchestra, the full volume of a concert grand piano in the same room, or the raging, raunchy thrust of the most punching rock sound.

Its midrange and high frequency electrostatic modules are angled to provide horizontal and vertical dispersion—creating a life-breathing concert-hall ambience that is unrivalled.

Its separate Brazilian rosewood veneer bass cube houses an 18" woofer with a 35 lb. magnetic circuit and a motion sensor as the heart of its servo mechanism system. The servo woofer, driven by its own 150 watt RMS DC servo amplifier, generates unparalleled distortion-free bass reproduction; articulate, tight and accurate.

Its electronic crossovers with high voltage FETS, and crossing over at 70 Hz and 2,000 Hz, provide perfect phase linearity over the entire musical spectrum.

In its unprecedented homogeneity and musicality, the Servo Statik 1A is a staggering achievement.

It costs around \$4,000.

Yet you don't have to spend \$4,000 to get typical Infinity clarity, transparency and depth of sound.

As we said, one of our objectives in conceiving the Servo Statik 1A was to develop a benchmark technology for a more "realistically" priced line of speakers.

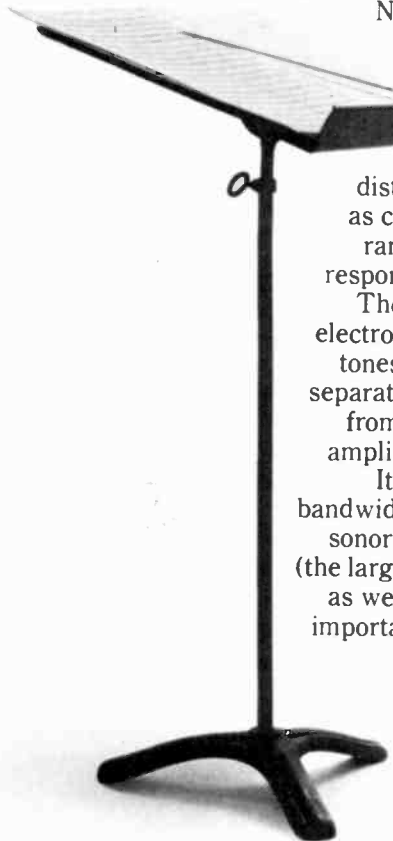
The result? Every Infinity speaker, from the POS II at around \$100 to the Monitor II at about \$450, has achieved superlative reviews from leading testing labs and audio reviewers.

Very soon Infinity will top these technological achievements by introducing the DSP Switching Amplifier™—not just a new amplifier, but a new *concept* of amplification; an esoteric technology that will have far-reaching effect in the audio and music industries.

We've restricted sales of the Servo Statik 1A to a select family of dealers. Drop us a note and we'll be happy to tell you the Infinity dealer nearest you.

We hope you'll treat yourself to the experience of listening to the Servo Statik 1A. Or any Infinity speaker.

You'll discover a totally new phenomenon: live music without the musicians.



 Infinity

We get you back to what it's all about. Music.

How Speakers Work

SINCE SOUND is essentially the movement of air at a frequency and amplitude sufficient to be heard, the basic job of a loudspeaker is to cause the air to move within the nominal audio range (20 Hz to 20,000 Hz) and with enough "thrust" to create sound waves. You can demonstrate this basic principle for your own edification: Grasp a piece of stiff cardboard and wave it back and forth near your ear. Note that the faster you wave it, the higher the pitch (frequency); the more forcibly you wave it, or the longer the distance of each wave, the louder the sound level (amplitude). So much for lesson 1 on how speakers work.

For lesson 2, ask someone (who won't think you're mad) to drone a simple monotone like a drawn-out "ah-h-h" and then hold cupped hands over the mouth while continuing to drone at the same pitch and loudness. The sound will immediately become louder and likely clearer, or at least easier to hear.

Lesson 1 shows how speakers generate sound. Lesson 2 demonstrates how sound is coupled to the environment. The whole technology of speakers—sizes, shapes, materials, enclosure designs, and so on—is built on these two basic ideas.

Their first commercial application was Alexander Graham Bell's telephone "receiver" in 1876, essentially a prototype of the headphone as well as of the loudspeaker. It was, in fact, a "speaker"—the "loud" part came a bit later with the development of the phonograph. The essential difference, in sociocultural terms, was that the telephone receiver

was (and presumably still is) a private listening device, while the *loudspeaker* is a group-listening device. To put it in technical terms, the telephone receiver (and its modern counterpart, the headphone) is designed to fill a very small "cup" with sound that is directly coupled to the ear. The loudspeaker is designed to fill a large space with sound that gets to the ear via the normal air and environment of a room.

The first loudspeakers were small discs that were attached to the vibrating stylus of the phonograph. The low-amplitude sound thus produced by this "diaphragm" was amplified in megaphone fashion via a horn. A marvel in its day, this design was crude and severely limited in response.

Attempts to build a better loudspeaker culminated in 1925 with the development (by two General Electric researchers, Chester W. Rice and Edward W. Kellogg) of a moving-coil or "dynamic" loudspeaker that was powered ("driven") from a 1-watt amplifier. This design, which marked the end of the era of the "Morning Glory" type of horn, coincided with the rise of radio sets powered from line-voltage rather than from batteries. Its development paralleled the work of the notable audio pioneer, P.G.A.H. Voigt who, at Edison Bell in England, was pioneering such (then) novel notions as free-moving diaphragms, huge magnets, aluminum voice-coils, and horn-loaded enclosures.

Today, speaker design is still very much an "open-ended" affair, with continued experimentation as characteristic as adherence to any es-

established rules. Indeed, we seem now to be in a period of re-examination of basic principles, not only those of conventional speaker design and performance but of the very methods for generating sound. This ferment is seen in the recurrence of such phrases as "true piston action," "omnidirectionality," "matching the speaker to the room," and so on. More to the point, it is evident in the new diaphragm materials that replace the older paper cone; new suspension techniques; new diaphragm shapes, including the oval and the rectangular. No less important is the employment of older techniques newly refined. Finally, there are designs that ignore the moving coil altogether and offer alternate methods of generating sound, such as the electrostatic and other types of speakers.

Dynamics Dominate

The prevailing design, however, remains the dynamic speaker, in which a moving "voice-coil" is made to vibrate in a magnetic field when fed with amplifier signals. One end of the coil is attached to the apex of a thin diaphragm, or cone, which vibrates with the coil to produce sound. Many design features contribute to the accuracy with which the vibrations correspond to the signals from the amplifier—i.e., to how good the sound will be. Among them are the efficiency of the magnet, the total inertia of the moving elements, the inherent resonances of the parts, the shape of the diaphragm, and so on. These features vary from model to model, but a paramount aim—whatever the design approach—is to get the diaphragm to behave like a true piston. The cone, made of felted paper and flaring out from an apex, lends itself to piston action, but such action—or the speaker's response—is limited by a number of factors. For example, the cone must be rigid or stiff enough to vibrate like a solid piston rather than like a piston-in-parts, lest breakup and its attendant distortion occur. At the same time, the cone should be light enough in weight to respond readily to the voice-coil's vibrations, thus avoiding another form of distortion. All other things being equal, the desirable cone is one that has a given amount of stiffness for the lowest possible weight, or what engineers call a favorable "stiffness-to-weight" ratio.

Another problem of the cone speaker is that its shape—particularly when it is fairly large—naturally produces good bass response, but fails to produce as good treble response. The deep cone shape, for one thing, tends to beam the highs instead of dispersing them evenly and smoothly. For another, the large cone is not as readily controlled, and has inherently lower resonances and slower movement

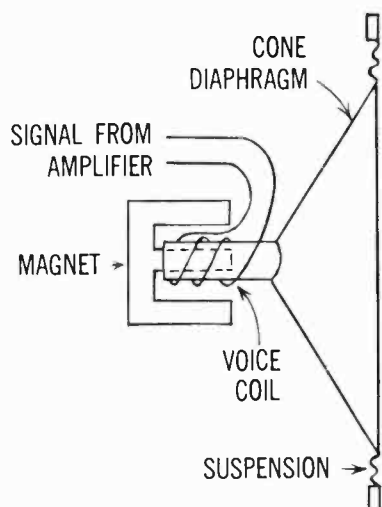
potential than the smaller cone. Yet, for treble response, a diaphragm that can move rapidly is a prime requirement.

Obviously, the features of a cone that make for good bass response do not make for good treble response. One widely adopted solution to this dilemma has been to treat a single cone in such a fashion that it acts in two different ways, acoustically speaking. The center area of the cone, extending two or more inches beyond its apex, is stiffened in order to raise its resonance to a frequency higher than that of the cone as a whole. A ridge circling this area separates it from the rest of the cone, which retains its original, lower resonance and is—by comparison with the center portion—less rigid, though stiff enough to respond to bass frequencies. This technique, known as "mechanical crossover," effectively separates the speaker's response to highs and lows between two different portions of the cone. Instead of one dividing ridge, some cones are made with a series of corrugations designed to have the same effect. One popular refinement of the technique is the addition of an auxiliary stiff, very small cone to the center of the main cone. Known as a "whizzer," it helps spread the highs and smooth the response. Speakers of this kind are known as "twin-cone," or "full-" or "wide-range," and are, as a group, generally suitable, though by no means the best available, for reasonably clean sound.

Less of a compromise is the speaker system in which separate drivers are employed to handle the highs and the lows. A crossover, or dividing network, is used to separate the signal from the amplifier and to channel correct portions of it to each speaker or "driver." Freed from the necessity of reproducing the full range, a woofer can be built to be a specialist at low frequencies. Similarly, the design of the tweeter can concern itself with the special requirements of treble reproduction, such as extended response for the highest overtones and wide-angle dispersion of them by means of small, specially shaped diaphragms, as well as by special structures fitted to those diaphragms. An advance over the two-way system is a three-way reproducer, in which the woofer and tweeter have less work to do individually, inasmuch as they are aided by a midrange driver, again designed specifically to cover a limited portion of the total audio spectrum. The most elaborate speaker systems employ four drivers, assigned to the deepest bass, the lower midrange or "upper bass," the upper midrange, and the extreme highs.

A recent solution offered to the problem of piston motion vis-à-vis weight and stiffness is the use of cone materials other than, or in addition to, the traditional paper. One very widely used is ex-

ELECTROMAGNETIC (DYNAMIC)



The heart of the dynamic speaker is an electromagnet surrounded by a moving coil popularly termed the voice coil. It receives signals from the amplifier which vary the magnetic field causing it to move in and out like a piston. The diaphragm attached to one end of the moving coil thus vibrates to generate sound.

panded polystyrene foam, alone or as part of a laminate with paper, aluminum, or aluminum and paper. Other materials gaining favor include rubberized plastic and specially prepared papers. The new materials provide a better stiffness-to-weight ratio in the interests of good woofer design, and lend themselves to the manufacture of smaller diaphragms more suitably shaped for good treble response.

“Loading” the Sound to the Room

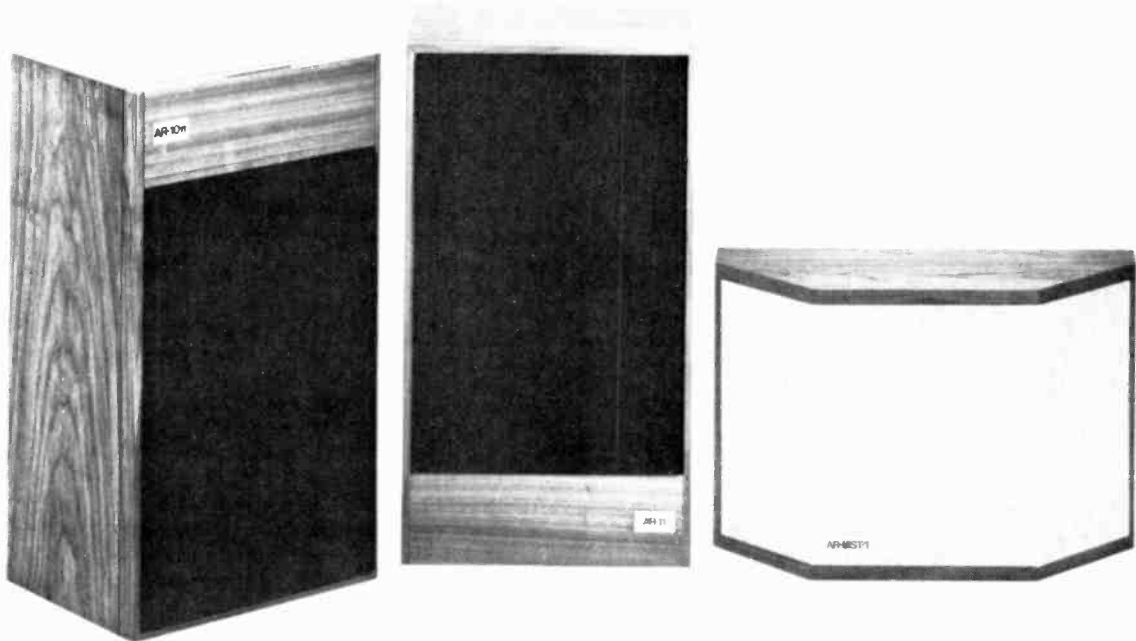
Whatever the design, a speaker represents—to the amplifier driving it—an electrical load or impedance. The input impedance to a speaker is very low because the voice-coil has an innately low electrical resistance, generally about 8 to 16 ohms and often lower than that. Ideally, this impedance should remain constant over the speaker's range to permit an optimum transfer of power from the amplifier. Variations in impedance during use can cause peaks and dips in the response (amplitude distortion), as well as changes in the time sequence of the related parts of musical signals (phase distortion). They also can contribute to whatever other forms of distortion may be present for other reasons in the speaker's output. Some impedance variation is inevitable; the impedance of a speaker, being an inductive effect, naturally rises with frequency. This

small increase, however, is not serious. More germane is the effect of reflected sound, a phenomenon caused by room dimensions as related to cone dimensions. Instead of the speaker wafting sound into the room, sound-wave patterns in the room push against the cone, causing distortion. To a great degree, though, their effects can be minimized by a speaker system designed so that its drivers will respond only over their most constant impedance ranges—again, a factor in the superiority of the multidriver reproducer to the single-cone speaker.

If the speaker presents an electrical load to the amplifier, the room acts as an acoustic load for the speaker. When a cone “looks” directly into the room it is said to perform as a “direct radiator.” The load on such a speaker is the air on its surface, and thus its acoustic impedance is determined by the area of the diaphragm. At high frequencies, this load is modified by the distribution pattern of the sound, which itself is determined by the shape, size, and number of tweeter diaphragms. The methods that make for a wider distribution pattern of highs also help match them to their acoustic load.

At low frequencies, the acoustic load is modified—usually adversely—by standing waves set up by a room's dimensions. These variations in turn modify the electrical load presented by the speaker to the amplifier. As suggested above, a well-designed woofer whose own impedance remains

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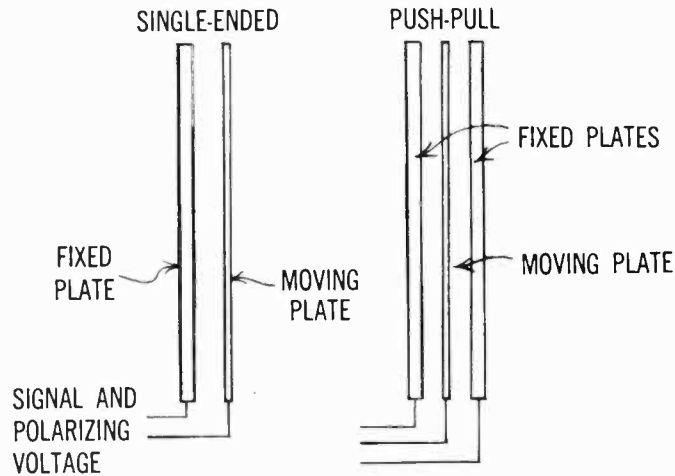
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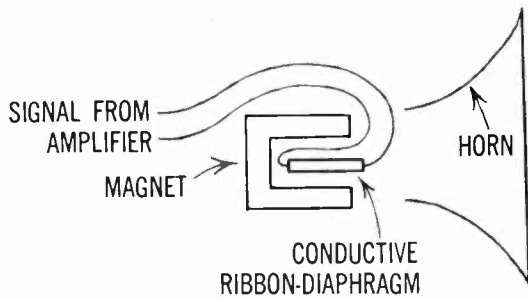
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ELECTROSTATIC



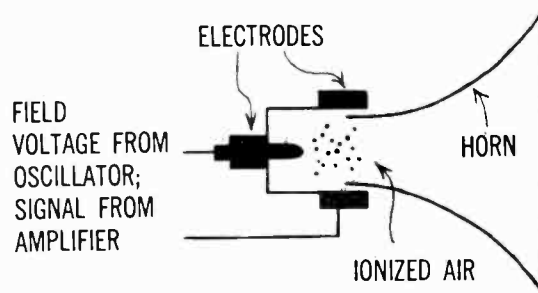
In an electrostatic speaker, the "diaphragm" is a thin movable plate that is spaced closely to a fixed plate. An initial electrical attraction between them is set up by a polarizing voltage, and the effect is similar to that of a huge capacitor. Signals from the amplifier then vary this attraction so that the movable plate vibrates to produce the sound. Electrostatic speakers require no enclosure as such, only a frame to hold the structure in place.

RIBBON



The ribbon speaker is an ingenious variation on the electromagnetic principle. The ribbon itself is a thin, flat conductive metal section that receives signals from the amplifier. It functions, in effect, as both "voice-coil" and "diaphragm." The sound energy it produces is quite low in amplitude and must be coupled via a horn to be heard in the listening area.

IONIC



The ionic speaker uses no diaphragm at all. Instead, the air in a small chamber is electrically charged so that it becomes ionized. This tiny "cloud" then is impressed with the audio signal from the amplifier so that molecular vibrations of air, corresponding to the signal, are set up. Because the amplitude level of these vibrations is very low, a horn is needed to couple them to the listening area.

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The trouble with "The Same Old Line" is that it assumes people listen with their eyes instead of their ears. There are charts and graphs to look at. Dozens of "Space Age" features to read about. And all kinds of sizes and shapes to confuse you. So, instead of coming on with the same old line, we've come up with some brand new speakers.

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fairly constant in the bass range will minimize these effects. But an equally, if not more, serious problem in bass reproduction is the tendency for bass tones to interfere with each other at their source. While high frequencies tend to form a beam, lows radiate much more circularly. Thus, the bass sound produced by one side of a cone can very easily "meet" the bass sound produced by the other side. Inasmuch as these two sounds are exactly out of phase with each other, they will negate each other when they do meet and thereby considerably reduce bass output. This phenomenon, known as acoustic short circuit, can occur at the outer rim of any speaker. To prevent it and permit a fuller bass response, the rear and front waves must be "baffled" from interfering with each other. Just how to baffle the cone speaker is probably the most controversial single issue in the whole field of sound reproduction.

Enclosures Are More Than "Boxes"

Although speaker enclosures are legion—in terms of size, style, shape, operating principles—there are some general factors relevant to all of them.

To begin with, when the rear of a speaker is enclosed in a finite space, such as a box, the space itself influences the speaker's response by limiting its cone movement at low frequencies. The exact degree of limiting depends on the size of the box and the cone's natural resonance—that is to say, its resonant frequency when unbaffled or in "free air." However, an auxiliary opening in the box—a "tuned port," or duct, or a labyrinth passageway—can be used to change the effect of the finite space so that it will aid, not restrict, the cone's movement at low frequencies. Enclosures of this general type, known as "bass-reflex" systems or resonators, are fairly efficient in that they actually make use of the speaker's rear sound waves, adding them to the front radiation to enhance the total output. A resonant enclosure, correctly "tuned" for a given speaker, can provide very acceptable sound and, indeed, such systems have been long-time favorites among many high fidelity enthusiasts.

On the other hand, if the rear of the speaker could "see" an infinite amount of space, that space would no longer be a factor in the speaker's response. Then, the speaker would respond as smoothly as its inherent quality and its front-loading allowed down to its natural resonance, below which the output would drop rapidly. Obviously, the speaker would have to have a very low natural resonance. Too, inasmuch as only its front radiation would be heard (half of its total sound output being dissipated), such a speaker would require proportionately more amplifier power to produce a

given volume of sound and would therefore have to be of sufficiently robust construction to accept that power without difficulty. A truly "infinite" baffle is patently impossible, and for most people, its practical equivalent has taken the form of a simple box. If large enough, and acoustically "dead" inside, the space in that box will not raise the speaker's resonance to degrade its bass response.

An ingenious variation of the infinite baffle concept is the acoustic-suspension system, or the infinite-baffle-turned-upside-down. The speaker, to begin with, is designed to have a very low natural resonance, below the audible range. This unusual characteristic is achieved by special techniques, of which the most conspicuous is a very loose, floppy suspension of the cone in its outer frame. To get such a speaker to respond from any bass frequency and upward into the audio range, the cone must be stiffened. This stiffening is accomplished by installing the cone in a small, heavily padded, tightly sealed box. The air trapped within the box acts as an acoustic spring against the cone, stiffening it to the point at which it will respond to amplifier signals. It should be added that the progenitors of this system emphasize that it was developed primarily because they found it to produce cleaner bass and less distortion than other speakers. The compact size, they point out, was a by-product of the design rather than a motivation for it.

One type of speaker system in which "designing for dimension" does seem to be a major consideration is the doublet, in which sound is made to radiate from front and rear, but without having to be baffled completely or otherwise necessitating a large box. In a doublet design the baffle area employed and the response of the drivers in it are calculated to provide different outputs from front and rear of the cone, or cones. The difference is obtained by such methods as using cones of varying resonant frequencies, or by mounting them so that the distances between the front and rear of any cone to the edge of the baffle are unequal. Such techniques can "frustrate" that acoustic short-circuit tendency and still permit good bass response. Doublet design has been used mostly to produce "slim-line" systems, although a few full-size and experimental systems have been made on the same principle. (The full-range electrostatic speaker, more of which presently, is a doublet by nature inasmuch as both of its sides radiate sound. Its bass response, however, is accomplished by techniques that have little to do with conventional enclosure features.)

All of these general types are direct radiators. That is to say, the sound produced depends directly on the amount of air on the surface of the cone. Power at the bass end depends additionally on the

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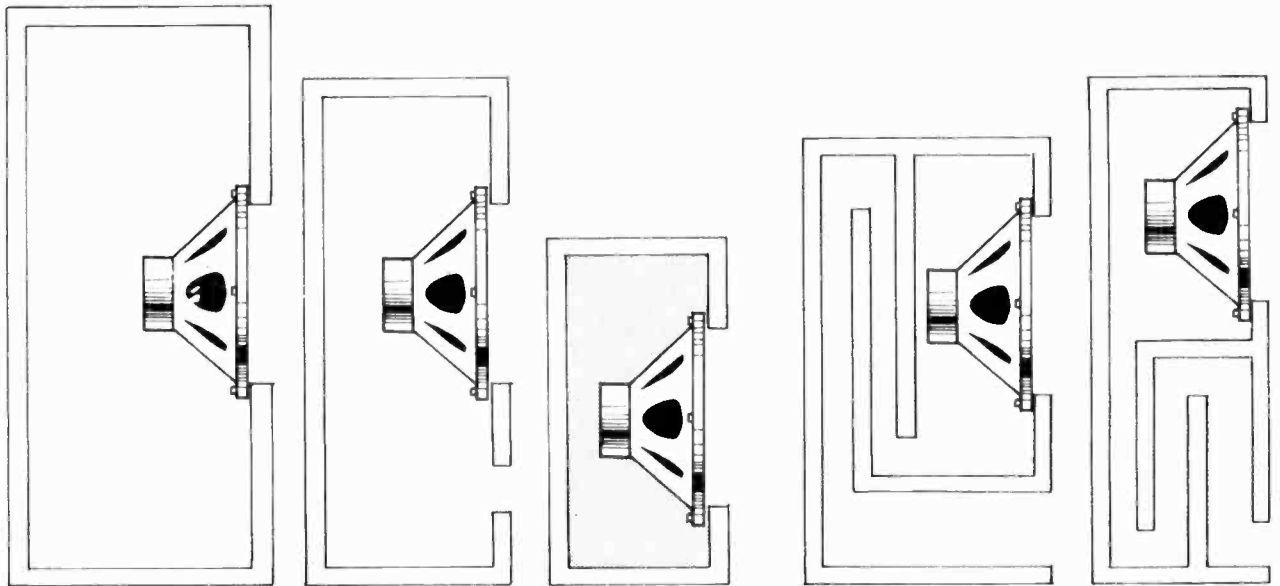
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Tracer II
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A: INFINITE Baffle

B: BASS-REFLEX

C: AIR-SUSPENSION

D: ACOUSTICAL LABYRINTH (left) and one possible transmission-line variation that enables "tower" design.

The infinite baffle (A) is a large, sealed box designed to completely "baffle" the speaker's rear wave from interfering with its frontal radiation. The box must be proportioned with respect to the size of the driver and its characteristic low-frequency resonance so that diaphragm motion is not adversely affected. If correctly dimensioned, the infinite baffle enclosure permits a speaker to respond smoothly down to its own natural resonance, below which frequency the response rolls off rapidly. This type of enclosure traditionally is associated with sturdy woofers of low resonant frequencies. Since only half of the speaker's total output is utilized, the system is of low efficiency and thus requires relatively high-powered amplifiers for appreciable sound levels.

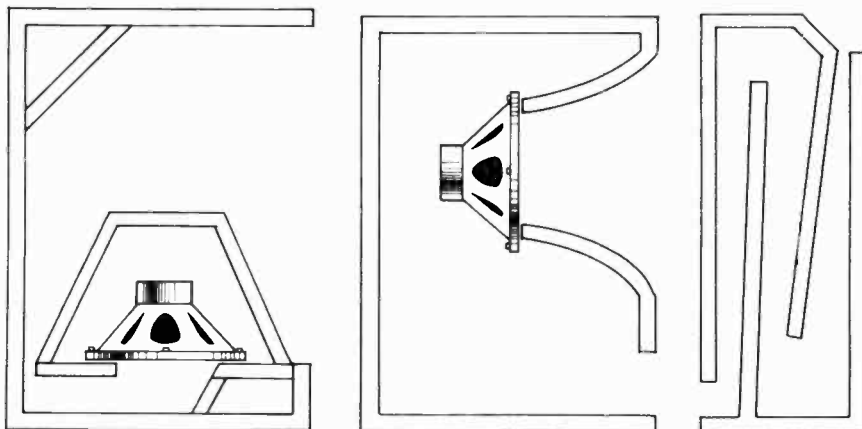
Infinite-baffle-loading can be accomplished by mounting a speaker in a large closet (if a clothes closet, so much the better since the clothing will help absorb the back wave), or in a wall between two rooms. In fact, the wall between two rooms provides the "most infinite" baffling since the large volume of air behind the speaker cone will never have a degrading effect on bass response.

The bass-reflex enclosure (also known as a Helmholtz resonator, or a phase-inverter), has an

auxiliary opening, called a port, which permits most of the speaker's rear energy to emerge in phase with the front radiation (B). To function correctly, the bass-reflex box must be built and proportioned with respect to the woofer's size, and the port must be critically dimensioned or "tuned" with respect to the woofer's resonant characteristics in that box. The bass-reflex tends to reduce the low-frequency resonance of the woofer and effectively extend its range. Since energy is available from both front and rear of the diaphragm, this system has relatively high efficiency and requires less amplifier power than an infinite-baffle system for a given sound level.

The air-suspension system (C) uses a relatively small enclosure that is tightly sealed and stuffed with sound-absorbent material in order to confine a given amount of air behind the woofer cone. The cone itself is specially made to be floppy in free air, with a low-frequency resonance that is below the normal audio range. The very loose suspension of this speaker becomes "tightened" by the trapped air so that the speaker can respond within the audio range. Because only half of the speaker's total output (its front radiation) is available, this system is of low efficiency and, like the infinite-baffle

BASIC ENCLOSURE TYPES



E: THREE TYPES OF HORN-LOADING

Front-horn-loading (left) uses speaker as compression driver. Design shown is simplified folded-horn design; "granddaddy" of folded horns, Klipschorn, is far more complex. Center drawing shows partial front-horn-loading combined with bass-reflex, while right drawing shows one section of double slot-loaded conical horn by Hegeman.

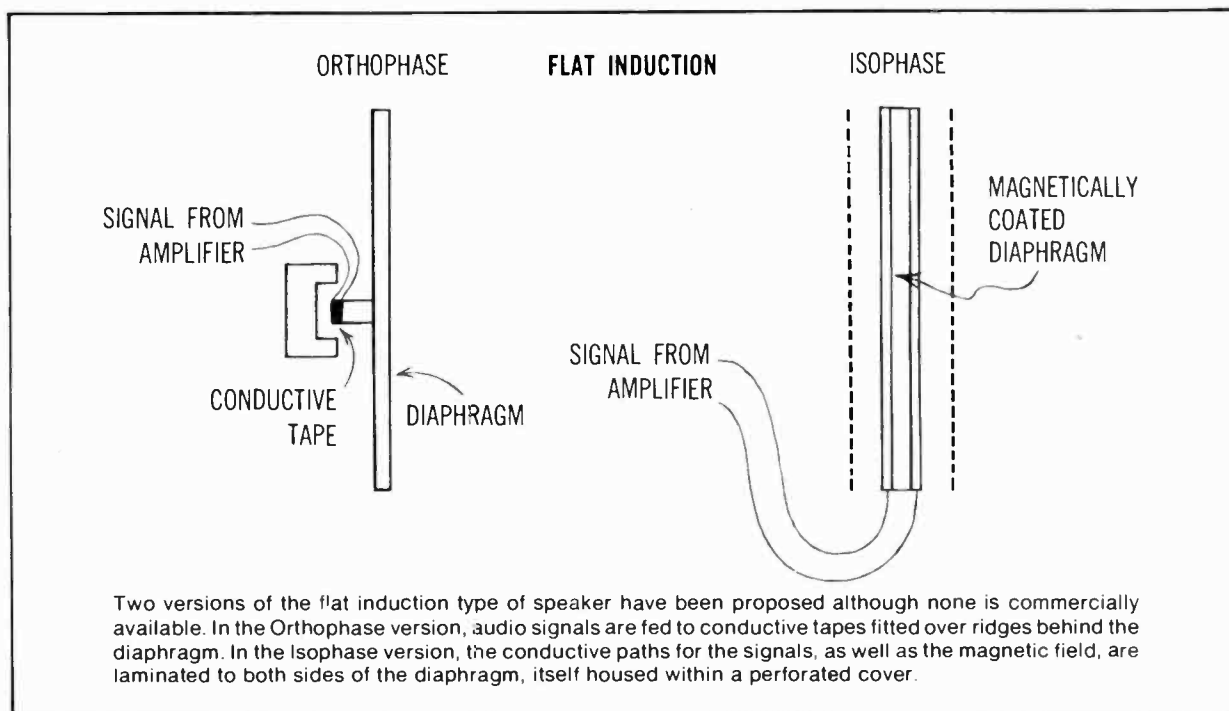
system, requires relatively high amplifier power for given sound levels. Note too that the comparatively small size of the a/s system (vis-à-vis the infinite-baffle or the bass-reflex) is not a matter of expediency or convenience, but is a direct consequence of its acoustic design, since the amount of trapped air is quite critical.

The tuned-column enclosure (D) covers another general class of speaker-loading, also known by such names as the "acoustical labyrinth" or the "transmission line." The earliest examples used the speaker as a direct radiator, but loaded a critically dimensioned passageway or duct behind it for improved low-frequency response. More recently, this passageway has been seen loaded to the front too in certain designs. It also has been heavily "damped" with sound-absorbent material so that the speaker's response is less influenced by the resonance of the column and aided more by a "smoothing" effect that avoids peaks in the sound. Efficiency of this general class of enclosure varies from model to model. The less-damped resonant types have an efficiency similar to that of the classic bass-reflex, while the more-damped types have less efficiency, about the same as air-suspension designs. Note too that while the

earliest duct-loaded enclosures had proportions not unlike those of bass-reflex or infinite-baffle enclosures recent models have taken advantage of the possibilities inherent in this design to assume a more columnar shape, popularly known as the "tower" design.

Horn-loading (E) may be applied to the front of a speaker or to its rear. When a speaker is front-horn-loaded, it becomes an indirect radiator—that is, its energy is transferred via the horn into the listening area and not directly from its diaphragm. As a result, rear baffling becomes less critical; there is little or no need to be concerned about improving response through influencing cone resonance. Despite the ignoring, in this design, of the speaker's rear-wave energy, front-horn-loading is the most efficient way of coupling a speaker's output to a listening area (the horn acts as an "acoustic transformer"), and such a system requires the least amount of amplifier power for a given sound level.

A variation on front-horn-loading is partial front-and-rear horn-loading; another would be direct radiation from the front and horn-loading at the rear. Designs of this type appear from time to time and are too varied to categorize definitely.



amount of excursion of the cone; the longer the excursion, the louder the bass. The “long-throw” woofer refers to bass speakers designed to have longer excursions than older models. Just how much longer entitles any woofer to be called “long-throw” never has been established, but most experts agree that a quarter-inch to one-half-inch excursion, without distortion, is long enough. Claims of excessive cone excursion, especially in low-priced speakers, should be viewed skeptically. Often such excursion can be accomplished only with high distortion. Sometimes, too, the figure quoted is the extent to which the cone was made to move by an unusually strong signal just before it was torn loose from its suspension.

Indirect Radiators (Horn-Loading)

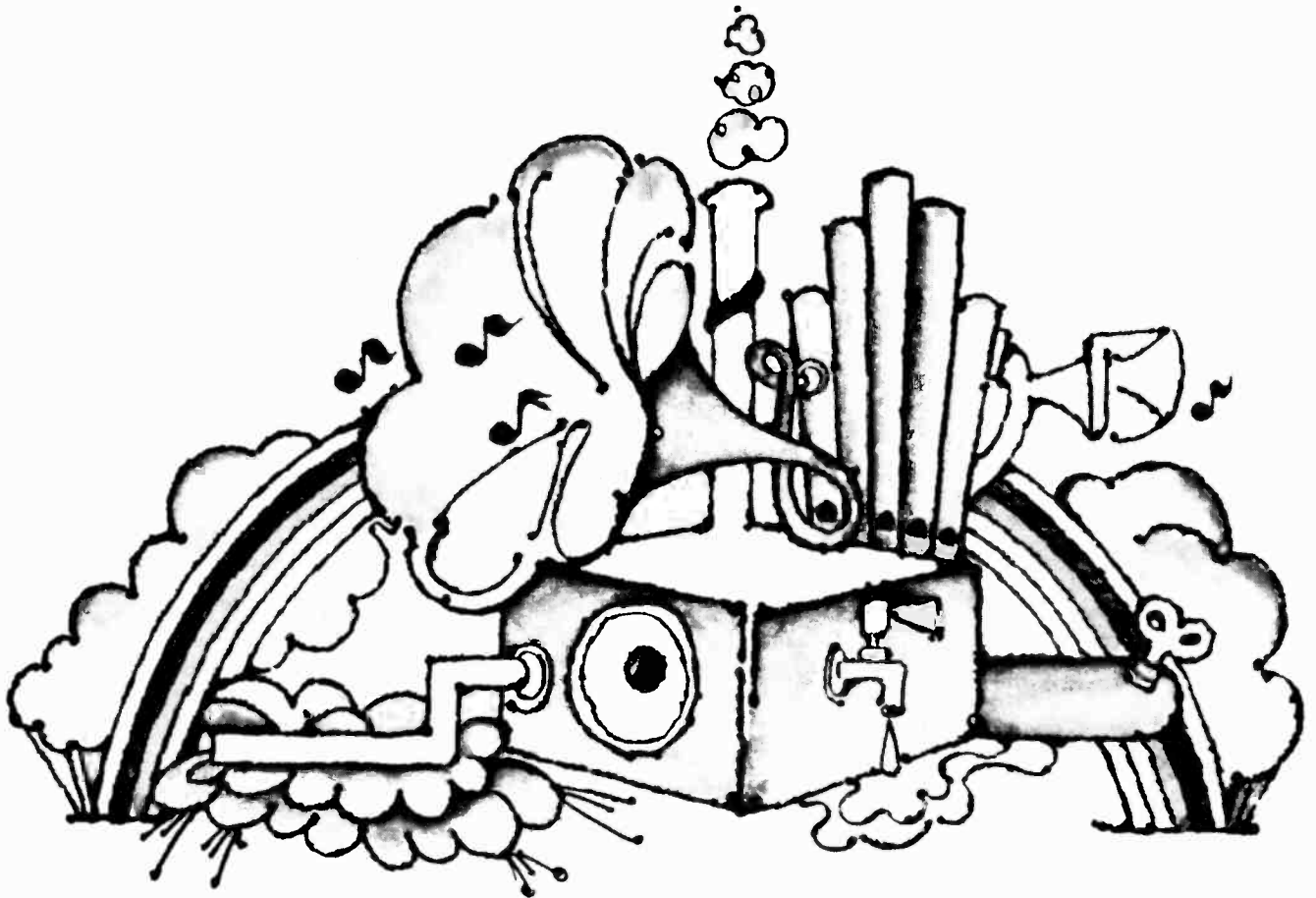
Another major class of dynamic systems is the “indirect radiator.” As the name suggests, the driver is not loaded directly to the air but rather through an intermediate device, something that can be regarded as an “acoustic transformer” in that it expands the acoustic load seen by the speaker. In practice, an acoustic transformer is represented by a horn that matches the relatively small and stiff diaphragm of the speaker to the larger, more compliant load of air in the room. Inasmuch as a horn changes the pressure relationships between a diaphragm and the air, its use makes the amount of rear baffling much less critical: that is, if a speaker is horn-loaded at its front, an enclosure behind it has much less effect on its performance than if the

same cone were used as a direct radiator. Any box used at the rear of a speaker that is horn-loaded at its front serves only as added assurance against an acoustic short circuit rather than as a means of improving response by influencing cone resonance.

The bass response of a horn is related to its size, and for deep bass a horn becomes quite large: something like a structure about twelve feet long and with a mouth diameter of seven and a half feet would be needed to reproduce a 40-Hz tone. Such horns have been built experimentally and for theater use, but the benefits of horn-loading did not accrue to home music systems until the horn was folded on itself and arranged to form a not impossibly large structure intended to stand in a corner where it used the walls of the room as part of its mouth opening. This system has been adapted and modified for use in many fine-sounding reproducers since it was first introduced in the early 1940s. The “full-horn treatment” renders the woofer useless above a few hundred Hertz and consequently involves the use of additional drivers to cover the rest of the audio range. The complex structure and the number and quality of drivers needed make it an expensive system. Efforts to produce simpler and less costly systems, still embodying something of the horn concept, have resulted in partial front-horn-loading as well as rear-horn-loading in which the woofer is permitted to respond more into the midrange, with only one tweeter and a simpler dividing network needed to round out the system.

Horns for tweeters can be quite small inasmuch as tweeter response not only can cut off well above

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the bass range but actually should do so. A horn-loaded tweeter, combined with a direct-radiating cone woofer, is a very popular combination found in many "coaxial" speakers, where the tweeter nestles very conveniently at the apex of the larger woofer.

Electrostatics and Other Types

A fairly serious challenge to the dynamic speaker has come from the electrostatic speaker. This type operates on an entirely different principle, and the conventional laws of baffling and so on simply do not apply to it. In an electrostatic speaker, sound is generated not by current flowing near a magnet but by the attraction and repulsion between two very closely spaced metal plates that are initially impressed with an electrical charge. A major advantage of the well-designed electrostatic is the tendency of its movable plate, or diaphragm, to move as a complete unit, that is to say, as the much desired piston. The "single-ended" electrostatic has one fixed plate and one movable plate that serves as the diaphragm. This type has been used for producing some very clean-sounding tweeters, but its mechanical limitations render it virtually useless for bass reproduction. The "push-pull" electrostatic, however, overcomes these limitations rather handily. In this type, the diaphragm is centered between two fixed plates. When one "pushes," the other "pulls." The resultant action greatly reduces distortion and, if the plates are made large enough, permits full bass response.

Another, entirely different, kind of speaker is the ionic, in which molecules of air, confined within a tube, are first charged electrically or "ionized" and then impressed with an audio signal from the amplifier. The vibrations of the air, rather than any moving member, produce sound. To be heard, the sound must be coupled to the room by a horn. Credited with producing very clean and undistorted sound, the ionic speaker has been employed so far only as a tweeter, to be used with more conventional midrange and bass drivers.

The "ribbon" speaker actually is a variation of the dynamic idea. A thin metal strip, or ribbon, suspended in a magnetic field, receives signals from the amplifier and vibrates in step with them. The ribbon itself serves as both "voice-coil" and diaphragm. In common with the ionic speaker, ribbon design has been limited to tweeters that require horn-loading to be heard.

Another type of speaker is best described as a flat induction transducer. Introduced in 1961 in Paris and dubbed the "Orthophase," this speaker employs a thin, rigid diaphragm, on the back of

which is a series of projecting ribs. Fitted over the ribs are magnets and under them, fastened to the ribs, are conductive tapes that carry the signal from the amplifier. The signal activates the ribs, which in turn move the diaphragm. Very fine piston action is claimed for this design, and those who have heard it attest to its clean, smooth sound—at least as a tweeter. Lowering its response, to include the bass range, would mean enlarging it, presumably by adding more sections to the basic diaphragm, which is itself about thirty-two inches square. The exact array needed for full-range reproduction has not yet been determined, and the cost has been estimated at perhaps \$1,000.

Somewhat similar, but having features unique enough to have earned a patent for its inventors at the Weitzman Institute in Israel, is another flat induction speaker. Known as the Isophase, this speaker employs—instead of actual magnets—numerous magnetic strips that are coated onto both sides of the diaphragm. A printed circuit—on a Mylar backing, and also laminated to the diaphragm—carries the signal from the amplifier. The diaphragm itself is enclosed in a thin, perforated housing, and the system may be used as a doublet or not, as the listener chooses. No one seems to know, or is willing to say, whether this design eventually will be released commercially.

The Walsh Driver

A radically different new loudspeaker is the Ohm A. Invented and patented by the late Lincoln Walsh, famous in high fidelity history for his Brook all-triode amplifier, it has no direct antecedents in the art (though some claim the Hegeman tweeters of the Fifties worked on the same principles). The Ohm A driver looks like an inverted funnel, the large end of which is fastened to an infinite baffle box. The funnel, or cone, is made of copper and titanium, forming a composite cone of rather large size and heavy mass. The theory of operation is, for the bass below 200 Hz, that of mass-loading; and, for the midrange and treble, high-velocity wave-train propagation down the cone, with radial propagation of all frequencies of musical interest.

The Ohm A has been publicly demonstrated and is in limited production. It is very inefficient, but when driven by amplifiers of sufficient power seems to give a good account of itself, according to many auditioners. Traditionally the British metal-cone speaker designs of the past (G.E.C., Jordan-Watts, and Jordan) have been lauded for their clarity while drawing some complaints of a metallic edge to high-frequency sounds. None has been precisely of the Ohm A shape, of course, and it will be

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ADS L700

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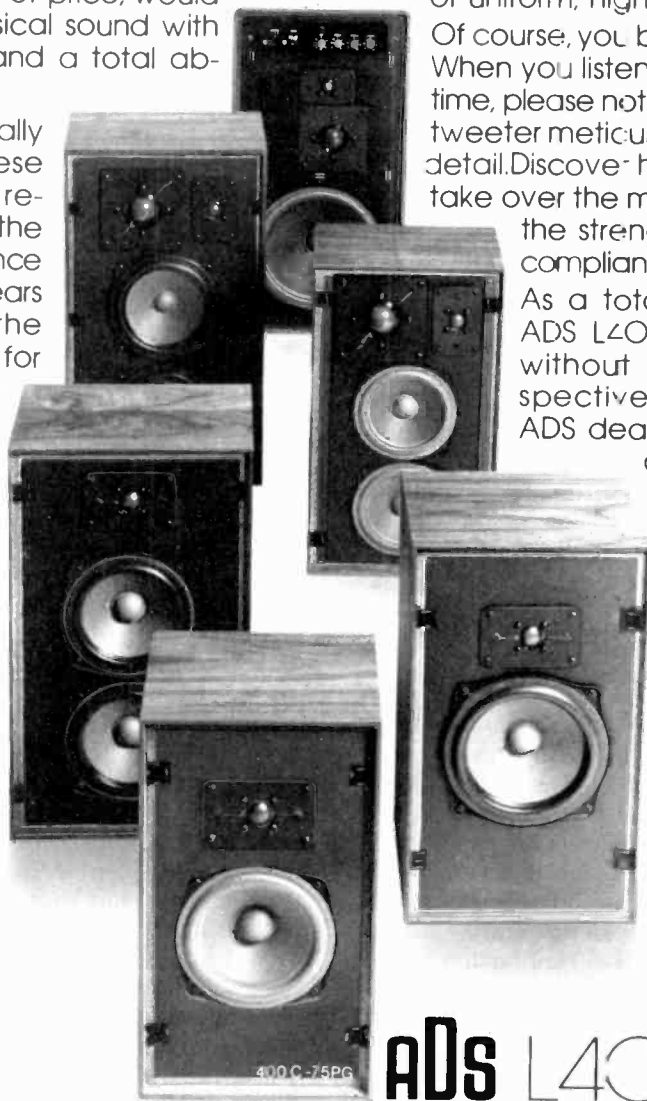




Diagram from Ohm Acoustics indicates how Walsh driver works. Conventional magnet-and-coil driver (top) produces wave in cone, which in turn excites air in contact with it. As wave moves down cone (second and third diagrams) it stays synchronized with acoustic wavefront (dotted vertical lines), progressively reinforcing it.

interesting to see what the final evaluations of the Ohm A will be.

Infinity's "Plucked" Tweeter

Very similar in design and built under the same basic Walsh patents—but intended only for treble propagation—is the Infinity Wave Transmission Line tweeter. The tweeter also resembles a funnel, but with the large diameter upward. This cone is made of plastic with a thin aluminum skin—a laminate that, it is stated, will support a sound transmission speed of 11,000 feet per second (about ten times that of sound in air). A voice-coil at the cone apex "plucks" it, causing it to emit waves orthogonally; i.e., in circles, spreading outward from the cone surface.

This tweeter is rated to handle up to 200 watts of program input and is said to display a flat impedance characteristic to 100 kHz; the designer says it can be driven at living-room level with a 25-watt amplifier—transistorized or tubed.

The Heil Air Motion Transformer

The firm of ESS has offered the Heil Air Motion Transformer as "the loudspeaker of the future." Invented by Oskar Heil, the unit is a midrange and treble driver whose corrugated plastic diaphragm (with imprinted voice-coil, called a "conduction cortex") folds on itself, reducing and expanding the volume of the "multiple interfacing cavities" presented by the magnet's vaned pole pieces and projecting sound outward with an "almost perfect transfer of kinetic energy." Dr. Heil further claims near-instantaneous acceleration of the diaphragm, very low distortion, and omnidirectional dispersion in the horizontal plane since sound is "squeezed" out from both front and back of the driver.

Very likely, the Heil unit will be endlessly dis-

cussed and debated by sound enthusiasts. Among other things it claims to be "the first new principle of sound propagation in fifty years." Various aspects of the design suggest past products such as the Kelly ribbons of the Fifties, the compression-throat tweeters of the Twenties, the perennial acoustic lens, and so on—all of which principles seem to be amalgamated in the Heil.

More Flat Diaphragms

Another company claiming to make obsolete all electrostatics is Audio Research, famous for its all-tubed amplifiers. The Magneplanar loudspeaker is offered as a replacement for free-standing, full-range electrostatic loudspeakers, intended to solve their inherent problems (particularly the need for a power supply) and to improve their quality and performance.

The Magneplanar stands six feet tall, four feet wide, and *one inch* thick! Each speaker is hinged twice like a folding screen, forming three panels that are set up in zigzag fashion: two with woofers, the other with the tweeter. Each woofer or tweeter diaphragm is made of thin Mylar (as in electrostatics), to which are glued closely spaced vertical wires. The diaphragm is stretched over a frame; bar magnets are attached to the same frame and interleaved with the wires, which make up the voice-coil. A crossover operates at 3,200 Hz, though there is provision for bi-amping if you prefer.

The Magneplanar bears a strong family resemblance to the short-lived Gé-Go Orthophase from France a few years back, though in modern dress. It sounds like no other loudspeaker, and is thus (again, as with the Heil) the center of brisk debate. One valid criticism is acknowledged by the manufacturer: its lack of extreme bass. A new add-on flat-panel subwoofer now is available.

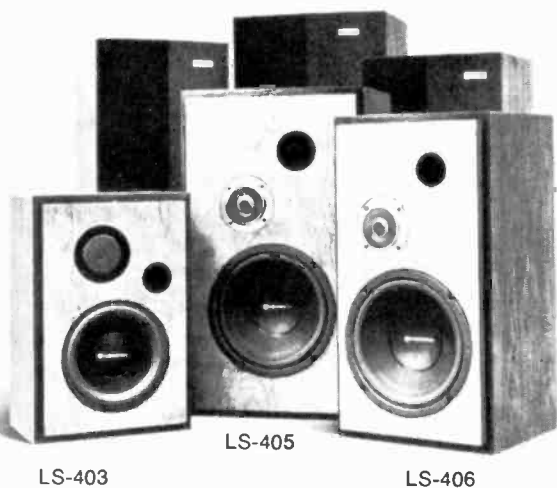
Another flat loudspeaker is the Fisher Sound Panel. While not claimed to be state-of-the-art, the

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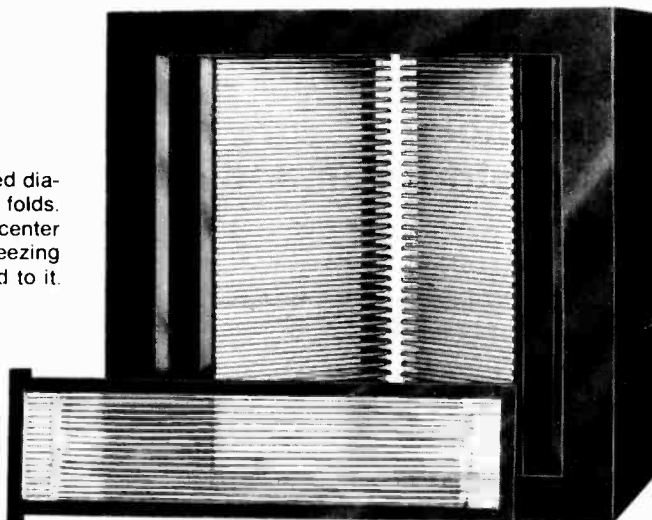
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The ESS Air Motion Transformer has an accordion-pleated diaphragm (removed, foreground) with conductors running in folds. Large magnet structure (background) has pole pieces at center that focus magnetic field in conductors, alternately squeezing and opening pleats when alternating audio current is fed to it.



unit is offered as an alternative to bookshelf loudspeakers. A single flat slab of acoustic polymer has two voice-coils fastened to it. Because of the panel's physical design and the placement of the two coils, one acts as a woofer and the other as a tweeter. Sound is produced equally from front and rear.

New System Approaches

Many recent speaker systems represent not necessarily new ways of generating sound as such, but rather new ways of using existing sound-producing elements to overcome many problems and deficiencies of older design approaches. One very well-known and widely acclaimed design in this general class is the Bose "direct-reflecting" system. As embodied in the Bose 901, it consists of nine medium-sized speakers mounted in a five-sided enclosure so that one speaker radiates directly into the listening area while the other eight radiate against rear and side walls for a "bounce-and-reflect" acoustic effect. The acoustic perspective may be varied by the distance chosen between a stereo pair as well as by their relative angles to the listening area. The 901 system is used with an electronic equalizer inserted before the power amplifier stages.

Other recent system designs include the use of a rotating driver (the Leslie system); the use of a movable treble section (as in the DVX system); the use of drivers facing upward (e.g., the Hegeman); the revival and improvement of the old "acoustical labyrinth" or "tuned column" type of loading, now renamed "transmission line" and prominently featured in many of the "tower" systems.

Yet another approach is the Dahlquist system, the product of a group headed by Saul Marantz and named after its designer, Jon Dahlquist. The Jon Dahlquist Phased Array speaker is planar. (The first samples looked like the Quad electro-

static.) It is not, however, a dipole (or doublet), radiating front and rear; Dahlquist strongly rejects such concepts. Rather he states that the flat shape is a device to avoid the diffraction distortions common to conventional enclosure loudspeakers. Mounted on the flat baffle are five dynamic speakers, each chosen for a special range of frequencies. These are joined by a complex crossover network, which equalizes their on-axis response with special compensation for on-axis time-delay distortions. The purpose of all this is to keep all phase relationships coherent—that is, in step with each other at all frequencies—just as they would be in radiating from a live source.

Dahlquist believes that a good loudspeaker should only operate on the frontal hemisphere, and never backward; that good dispersion forward is a virtue; but that it is better to have poor dispersion than to let any signals be reflected. Indeed, the design concept of the loudspeaker is to keep from "wasting energy" in other directions and to keep from confusing the stereo image. Mr. Dahlquist, it might be noted, speaks from a vast background of research and development on other kinds of loudspeakers—and sounds like a spokesman for the English (BBC) school of speaker research, or the corresponding French (ORTF) school. His ideas and his patented speaker represent a divergence from the prevailing U.S. school of wide, or even omnidirectional, dispersion. The design is a refreshing restudying of the principles of sound propagation and of the relationship of the speaker to the room and to the listener.

The new designs and the improvements in older designs add up to one general conclusion: In loudspeakers, nothing is sacrosanct. It seems there is no rule that cannot, or has not, been broken. Indeed, the only rule that would seem to apply is that of cost: In speakers you generally get what you pay for.

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After years of research, Bang & Olufsen has created a speaker system that provides the missing link in speaker engineering by virtually eliminating audible phase distortion.

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Now you can hear musicians on your stereo sound stage (your listening area) as they were recorded: from front to back, as well as from side to side. With excellent transient response, definition and clarity.

But let's backtrack and see exactly how Bang & Olufsen got so far ahead.

The problem of phase distortion.

Phase distortion occurs in multiway conventional speakers at the crossover point when the same note is being reproduced simultaneously by two drivers. It is most noticeable at lower frequencies and during tran-

sients (sudden variations in volume). What you hear is a blurred sound picture, lacking definition.

There are two characteristics to phase distortion: one is fixed, the other is variable. In conventional crossover filters, alternating driver units are fixed mechanically and electrically 180 degrees out-of-phase (to compensate for amplitude "suck out"). (See Diagram A.) Variables in phase shift are due to passive filter components.

Today's high-quality loudspeakers have virtually solved the problems of frequency response, as well as harmonic and intermodulation distortion.

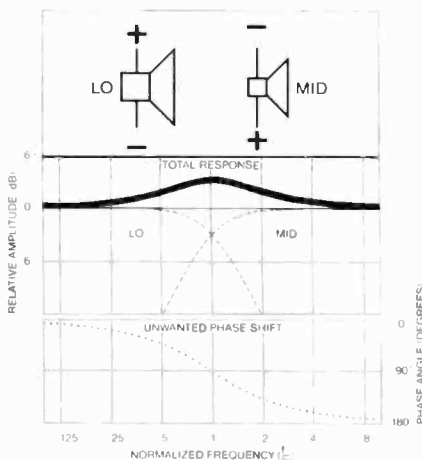


Diagram A: Conventional 12dB/oct. crossover filter.

Which makes the study and correction of phase distortion, the final hurdle in speaker perfection, all the more important and meaningful.

A discovery we really listened to.

At the 1973 AES convention in Rotterdam, two Bang & Olufsen engineers, Madsen and Hansen presented a paper on audible phase distortion that represented three years of research.

They had created an electronic crossover, tri-amplified speaker which totally eliminated phase distortion. From it, they concluded that phase distortion is the remaining main source for sound coloration in conventional speakers.

That it is, indeed, audible at lower frequencies and higher volume levels.

The solution: the Phase-Link method.

Madsen and Hansen's electronic crossover speaker was, of course, cost-prohibitive to the consumer. So Bang & Olufsen set about creating a practical solution.

E. Baekgaard, head of the Bang & Olufsen electrical engineering department, developed a mathematical computer simulation of the loudspeaker's electro-acoustic

transfer function. And he began experimenting.

Instead of placing alternating drivers 180 degrees out of phase, he put them all in the same phase, "curing" the fixed phase shift. This created an audible amplitude "suck out," (See Diagram B) which led to the discovery of the missing link.

An additional narrow band filler driver at the crossover point. It "cured" both the amplitude "suck out" and the variable phase shift by providing a compensating signal between the woofer and midrange.

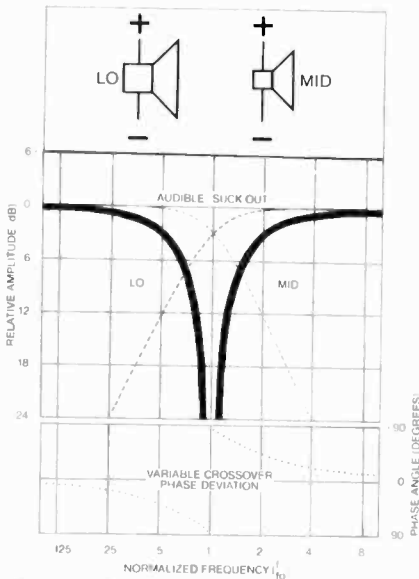


Diagram B.



Because the ear is sensitive to phase distortion mainly in the lower frequencies, phase link is only used between the low-frequency driver and the midrange unit in the high-power, 3-way (M70, S60) systems and not between the midrange and the tweeter. In medium-power, 2-way speaker systems, one phase link is used in 12dB/oct. (S45, P45) filter combinations. Low-power, 2-way speaker systems can be made without phase distortion through a sophisticated 6dB/oct. filter technique (S30).

Cabinets are supplied in genuine rosewood, teak and oak veneers or white lacquer over birch applied to tough, rigid particle board.



Diagram C: The Bang & Olufsen new dynamic filler driver eliminates phase distortion.

And it made the audible output identical to the electrical input. (See Diagram C.)

Today, our Beovox Phase-Link loudspeakers have even further refinements. The drivers are mounted to form a common, angled baffle, acoustic axis to ensure that the sound generated from each driver will reach the ear simultaneously.

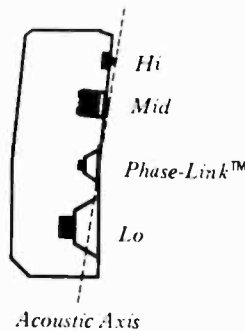


Diagram D.

(See Diagram D.) These speakers are so acoustically accurate, they can reproduce an electronic square wave signal. Proof that they have excellent frequency response, low distortion, and are free of audible phase distortion as well. (See Diagram E.)

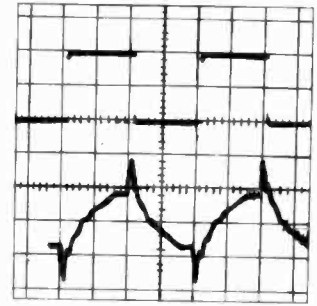
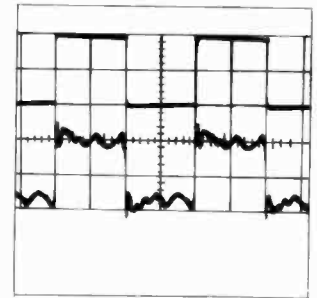


Diagram E: 1. A good conventional speaker with wide, flat frequency response and low distortion still cannot reproduce the original square wave signal.



2. Beovox Phase-Link loudspeakers can reproduce square wave accurately by virtually eliminating phase distortion.

Your Stereo Sound Stage.

More than stereo separation, Beovox Phase-Link loudspeakers produce a total stereo sound picture. With notes retaining their clarity, free from hangover because of excellent transient response. Which means that in a fine recording, you'll be able to sense where every instrument and section is located.

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How to Choose Your

Test reports help, but your ears

CHOOSING SPEAKER systems (a pair for stereo, or two pairs for four-channel sound) can be a demanding job for the serious listener, but it also can be very rewarding. Up to the speaker(s), the music is a "signal"—an electrical replica of real sound. The speaker has the critical job of translating that signal into living sound. How critical this job can be, and how varied its outcome, depending on the speaker, is easily demonstrated by changing the speaker in a typical TV set for a hi-fi model. You'll hear things from that TV set you never heard before: a wider response and a fuller tone—as well as the raspiness and distortion of the TV's audio section.

A speaker system, then, is a sonic window on the entire playback system. The better it is, or the higher its "fi," the more it will reveal both the excellence and the flaws of that system and of the program material played through it. A speaker that makes everything sound the same is, to that extent, not a high fidelity speaker. But the more revealing a speaker is of tonal variations inherent in recordings or even in different FM stations, the more faithfully or accurately that speaker is reproducing the signals fed into it.

How do you judge this quality and then relate it to your own system needs in terms of such considerations as size, personal listening preferences, amplifier power? There are, generally speaking, two approaches. One is to follow the published test reports on speakers (such as those appearing regularly in *HIGH FIDELITY* magazine, and reprinted in its *TEST REPORT* annual); the other is simply to listen for yourself. Ideally, the listening should at-

tempt to relate what you hear with what you have read about a particular model. But whether or not you can make this relationship in all instances, there are some guidelines, for both understanding test reports and for your own auditioning, that can help you through the plethora of speakers on the market to a wise choice for your own sound system.

Test Reports and How to Read Them

To begin with, it must be emphasized that no set of "numbers," no matter how carefully derived, can tell you fully just how a particular speaker will sound, especially when installed in your room. What lab tests can do, however, is suggest what you may expect to hear. They also provide a basis for comparing certain aspects of performance among various models since all tested units are subjected to the same treatment.

Impedance The impedance of a speaker (its voice-coil resistance combined with various reactances) is the actual load presented to the driving amplifier. Typical manufacturer ratings for impedance are 4, 8, or 16 ohms. These ratings, however, are not constant inasmuch as speaker impedance changes with the frequency of the applied signal. A typical impedance curve is shown in the accompanying graph (Fig. 1). Note that at speaker resonance (about 100 Hz) impedance rises, then it drops. The value in ohms at the "low point" (past the bass rise) is stated, as is the impedance measured over the rest

Speakers

are the final judge.

of the audio range. Thus, this particular speaker would be said to have an impedance of about 6 ohms just past its bass rise, and to average about 8 ohms across the range—which is satisfactory and qualifies as an “8-ohm” speaker.

If the impedance is found to dip significantly low, this fact will be mentioned so that you can be assured of your amplifier’s safety when used with that speaker. The impedance information also relates to the use of two speaker systems connected in parallel across the same amplifier output terminals. For instance, while a dip in impedance to, say, 5 ohms is of little importance for a given speaker system, that same dip on the part of two such speaker systems produces a net impedance of only 2.5 ohms, which could be dangerously low for some amplifiers or receivers. Usually the owner’s manual (for the amp or receiver) states the minimum safe impedance to use.

Frequency Response Simply stated, a loudspeaker’s frequency response is the sound pressure it produces at some finite distance in front of its surface as a function of the frequency applied. Just what constitutes “good” or even “acceptable” frequency response from a loudspeaker never has been clearly defined. Nor can we discern much general agreement on specific numbers in this area. Some years ago, Harry F. Olson, the noted acoustician of RCA Laboratories, published a fairly definitive set of criteria for high fidelity loudspeaker performance in which he proposed uniform response from 30 to 15,000 Hz, with a maximum de-

parture from such uniform response of no more than 5 dB at 100 Hz and 8,000 Hz, and a maximum departure of no more than about 8 dB at the extremes of 30 Hz and 15,000 Hz. Interestingly, Dr. Olson allows no provision for *peaks* above an average “zero-dB” level, only for moderate amounts of attenuation. This concurs with the opinion of many experts who have long maintained that narrow peaks of departure from uniform response are much more annoying (and tend to add to so-called speaker coloration) than are slight *dips* of equal amplitude. While Olson’s prescription is properly rigorous, we have found in the course of testing modern loudspeakers that a smooth rise *above* zero dB by no more than, say, 5 dB does not degrade the sound of a loudspeaker *that has very good performance characteristics in important areas other than frequency response.*

In judging a loudspeaker’s frequency response in conjunction with a HIGH FIDELITY equipment review, first examine the “on-axis response curve” of the speaker to be evaluated. This is the simplest frequency response curve, since it is concerned only with the ability of the speaker to reproduce all frequencies uniformly directly in front of the speaker radiating surface. If, for example, you note a significant “valley” in the curve in the midrange region (frequencies from about 300 Hz to about 2,000 Hz), listen particularly for definition of individual orchestral instruments and for “presence” in vocal selections. Lack of midrange response often tends to make vocalists sound subdued—almost as if they are singing from somewhere *behind* the ac-



Fig 1. Impedance curve.

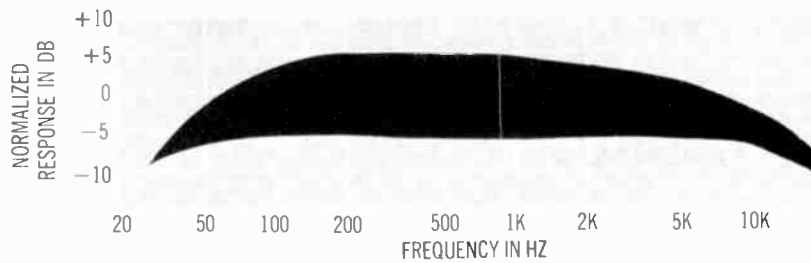


Fig 2. Shaded area represents typical response limits of high-quality loudspeakers, approximately plus or minus 6.5 dB from 30 Hz to 15,000 Hz. The smoother the curve (i.e., the fewer dips and peaks) within this area, the better. "Normalized" response refers to the zero-dB reference line's being drawn through the center of the total dB variation, although the actual response measurements are made for a constant 1-watt input, with approximately 80-dB sound-pressure level resulting as the most often encountered nominal average speaker output.

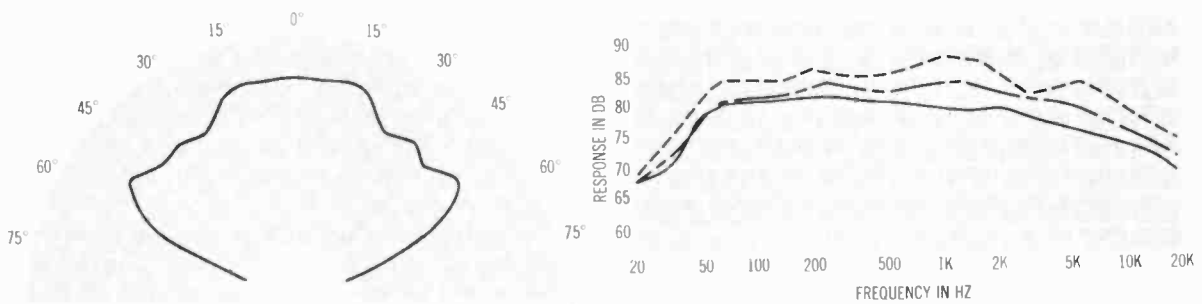


Fig 3 (a and b). Conventional method of presenting loudspeaker dispersion data (left) does so on an absolute basis for only one frequency at a time (this graph shows a polar pattern measurement at 5,000 Hz). In contrast, CBS Labs response curves, which are used in HIGH FIDELITY's test reports, show complete frequency spectrum on a comparative basis: direct on-axis response, average front hemispheric response taken from five points, and average omnidirectional response taken from fourteen points. The most significant curve from the listener's standpoint is the third (omnidirectional) curve, but by comparing the contours of the three curves, you can form a good idea of the speaker's directivity in terms of actual dB differences all across the total audio band.

companying orchestra. A premature rolling-off of low frequencies appearing in the curve will show up in your listening tests as a distinct lack of "full-bodied" bass when such instruments as bass violins, kettledrums, and even the lower octaves of a grand piano are used as auditioning material. To some degree, male speaking voices also will be affected; they will especially show "coloration" when a peak of a few decibels occurs in the frequency response between 100 Hz and 300 Hz. This peak causes the so-called "bass-boom" or "one-note-bass" effect often heard from mass-produced console sets. The truth is that many of these sets have a built-in peaked bass response to give the untrained listener an impression of "real bass." If you're in doubt, just listen to any live male voice and compare it with the sound of a reproduced male voice.

If the on-axis frequency response curve shows high-frequency response poorer than that suggested (in Fig. 2), you have another clue to speaker performance. To verify it, listen to musical selections containing strong high-frequency signals (cymbals, triangles, and the like) as well as to the consonants in speech such as *s*, *f*, and even the letter *t*. If their crispness and definition seem wanting in an *on-axis* test (where highs are more easily projected from a loudspeaker than at any other listening position), you may be fairly certain that degradation will be even more extreme at any other listening position relative to the speaker's axis.

In addition to these obvious performance aspects, a few less apparent but equally important speaker characteristics should be considered. If the pressure waves created by the moving diaphragm of a loudspeaker could be directly coupled to the listener's ear, our discussion of frequency response evaluation could end right here. (In fact, properly designed headphones work exactly that way. When using headphones that form a good seal with your ears, you eliminate all problems of room acoustics and of directivity or "angular dispersion." All reproduced frequencies are channeled directly to your hearing system, which probably explains why more and more stereophone enthusiasts maintain that no listening is as faithful to the original or as devoid of coloration as headphone listening. Since we are dealing with loudspeakers, however, we must face up to additional considerations.)

Response and the Room Regarding the so-called ideal home listening area, in the last analysis how many readers will actually redecorate their living rooms or dens to conform to that ideal? Many listening rooms, in fact, do not even have the most desirable dimension proportions (3:4:5). Here is one area of speaker evaluation in which intelligent subjective listening can again supplement objec-

tively determined measurements and reports. Try to do your auditioning in a dealer's showroom that is not too unlike your own listening area—both in dimension and in sound-absorption treatment. Since one of the most often heard complaints from owners of newly acquired speaker systems is that "they didn't sound that way when I listened to them at the dealer's showroom," try to get the dealer to let you "final test" the speakers of your choice by taking them home for a few days.

Faced with the problem of room acoustics and your own listening position (which is most likely to be *off-axis* in any reasonable stereophonic arrangement), you need to concern yourself with another important characteristic brought to light in the current method of HIGH FIDELITY speaker reviewing—that of directivity. If you examine the other two frequency response curves given in a HIGH FIDELITY speaker report you will see that they are identified as "average front hemisphere response" and "average omnidirectional response." Generally, the three curves are almost identical up to frequencies of about 150 Hz or so because bass tones emitted by a loudspeaker tend to be nondirectional. Mid and high frequencies, however, become increasingly directional so that as you move off-center of the speaker axis, these frequencies will sound weaker unless certain design precautions are taken. In stereophonic listening this is particularly significant, because the listener is more often than not well off-center of the axis of either speaker (hopefully somewhere in between them), subtending an angle of 45 degrees or more to either speaker.

The two additional frequency response curves shown in the published test reports take cognizance of directionality by including separate measurements taken from various points around the speaker. One of these curves represents average radiated sound-pressure level ("equivalent omnidirectional response") while the other corresponds to average front hemispherical response. They provide a complete and easily interpreted picture of both frequency response and directionality characteristics. Previously, directionality of a loudspeaker was usually shown by plotting a polar radiation pattern (Fig. 3a). The problem with this type of graph was that a whole series of them would be needed (one for each frequency tested) to truly define a speaker's directional characteristics.

The new presentation (Fig. 3b), which includes the two additional frequency response curves, tells you at a glance just how well the speaker can radiate energy over the entire frequency range and into the entire listening area. As you listen to a speaker which has been reviewed by this new method, you will want to walk to the extreme corners of the

room—to every conceivable off-axis location in which you or other listeners in your home may be listening. If the two off-axis-derived curves (particularly the one identified as “average omnidirectional response”) exhibit marked attenuation characteristics above 1,000 Hz, pay special attention. Should you plan your home seating arrangement at a considerable off-axis angle from such a loudspeaker you are likely to sense a deficiency of high-frequency response. Try, therefore, to duplicate this condition in the showroom by moving away from “stage-center” and determining whether you can, in fact, notice the loss of highs which the published curves “predict.” Again, this is best done by playing music that is rich in high frequencies. Many recently designed “omnidirectional” speaker systems tend to overcome this problem by using multiple drivers for their high-frequency array, often directing them away from the listener, so that the sound is dispersed by reflecting walls or other surfaces. This type of speaker reduces the undesired beaming effect of the highs and tends to average out the high-frequency energy radiated in a room. If you find that such a system pleases you and that the published curves confirm your high opinion, bear in mind that the smoothness of high frequency response depends in part upon where that speaker is located with respect to available reflecting surfaces. Should your home listening situation preclude such positioning, the high-frequency dispersion of these types of speaker systems may well be altered unfavorably.

Another point to remember when considering the high-frequency dispersion characteristics of any speaker system is that many systems are equipped with some sort of high-frequency control—either a continuously variable adjustment or a multiposition switch. Check the setting of such controls as you audition the speaker. As a rule, the curves shown in the published reports are derived with all controls set to their indicated “normal” position. However, the effect of the controls on the response also is described. Thus, you should audition a speaker with the controls set for neither boost nor cut, and then vary the controls while listening for the specific changes indicated in the report.

As a final check, after you are satisfied that the high frequencies are well dispersed to preferred listening positions, return to the “on-axis” position (directly in front of the speaker). Try now to judge whether the highs sound strident or overly obtrusive, particularly if the on-axis curve of the report shows a substantial increase of amplitude in the frequencies above, say, 4,000 Hz as compared with the other two off-axis curves. This procedure is ad-

visible since in some instances you or others in your listening group may find yourselves in an on-axis position after all.

Distortion Distortion in speaker performance has been, and still is to some extent, a confusing subject. The reports in *HIGH FIDELITY* (based on tests run at CBS Laboratories) include data on harmonic distortion, and a few speaker manufacturers also are beginning to state something about distortion in their descriptive literature. Their reluctance on this point stems from their apprehension that the reader will equate the distortion figures of speakers with those normally encountered in connection with tuners, amplifiers, etc. The latter figures are minute by comparison. For instance, 5 to 10 per cent harmonic distortion at normal operating level would be considered horrendous in an amplifier, but of far less significance in a loudspeaker. Of course, by definition, the lower the distortion the better—in any audio device. Still, to understand what 10 per cent distortion at 40 Hz means for a loudspeaker, one must understand the nature of the distortion tests themselves. Suppose a speaker produces 10 per cent distortion when it is fed with enough electrical energy to furnish an average output sound-power level of 100 dB. The same loudspeaker will produce a sound-power level of 90 dB (putting you just a few rows back in the imaginary concert hall) with only 2 per cent distortion. In general, the greater the sound output, or the lower the frequency (below the bass resonance of the system, at least), the higher the distortion. To put these figures in perspective, sound levels of 90, 100, or even 110 dB correspond to the loudest sounds normally encountered in a concert hall. For this reason the 100-dB (or in some cases, the 90-dB) level becomes the one we *try* to get from every loudspeaker—including those that can produce such loudness only with “break-up” or “buzzing”—that is, with relatively high distortion. However, the tabulations used in the reports also show what happens when the speaker is driven to lower sonic output. The prospective buyer then can plan accordingly. If, for example, your budget permits purchase of a system that cannot cleanly reproduce those concert hall levels in your living room, it's nice to know that the speaker of your choice will, nevertheless, give clean output at an 80-dB level, even at the difficult low frequencies. The distortion tables thus provide a much better guide in this respect than a single statement such as “5 per cent distortion at 50 Hz” which is absolutely meaningless (though still used in some advertising) when unaccompanied by some indication of sound output level, or electrical input requirement plus an in-

dication of the system's efficiency.

Using HIGH FIDELITY's published distortion data, you can judge a speaker system's distortion fairly easily. First, listen to an assortment of recorded material at moderate levels—well below the point where significant distortion figures apply—and familiarize yourself with the over-all tonality of the system in question. Then, in separate steps and listening to the same recorded passages, increase the level of sound with the amplifier's volume control. At some point you will begin to hear a decided change—a decrease in the “cleanness” of the signal, particularly in the bass and lower mid-range region. This point will, as a rule, correspond approximately to the dB level at which the tabular report first indicates higher orders of distortion. If that level seems overpowering—and one that you are not likely to require in your home listening environment (either because of personal preferences or considerations of neighborliness)—then the onset of distortion at such a level is of academic interest only; it need not dissuade you from purchasing the system in question. In conducting these tests, however, you should allow for some margin inasmuch as the dynamic range of some future musical programming may be such that instantaneous crescendos may “push” the speaker into objectionable levels of distortion—if only for short durations. By basing the distortion tables in the reports strictly upon output sound levels (and not amplifier power applied to the loudspeaker) any consideration of speaker efficiency as such is deliberately ruled out for the purposes of this test. But efficiency is important for other reasons too, as discussed below. We mention it here, however, to remind you to be sure that an amplifier of ample, clean power output is used for listening tests—otherwise you may be listening to amplifier distortion or overload rather than the distortion caused by the speaker's limitations. In this regard, at least, most manufacturers of loudspeaker systems are careful to recommend required amplifier power for use with their products. We suggest allowing a margin of perhaps as much as 50 per cent plus in this area—because the chances that a good high-powered amplifier will “burn up” the loudspeaker are less likely than is the chance that the opposite will pertain, namely that a low-powered amplifier will be unable to drive an inefficient speaker system to levels at which it is still relatively free from significant amounts of distortion.

Judging Transient Response Since the early days of speaker evaluation, nearly every reviewer has spoken of good or bad “transient response.” This term refers to a loudspeaker's ability to respond with

precision to sharply defined percussive sounds of short duration. Such sounds occur often in music and are produced of course by percussive instruments. Moreover, it has been suggested by some experts that all music (whatever the instruments producing it) is actually a series of “percussives” or “transients”—an interesting idea that further points up the importance of this characteristic. Anyway, the best program material for evaluating transient response is music that abounds in obvious percussive effects.

As additional help, HIGH FIDELITY's published test reports approach the problem in a somewhat more concrete and scientific way. Carefully tailored “tone bursts” are fed into a loudspeaker, while its output is observed on an oscilloscope at various sound levels. The outputs are compared with the inputs for evidence of transient response defects such as “hangover,” “ringing,” or “muddiness”—defects which were often suspected but never easily confirmed quantitatively by experienced listeners in the past.

While the published reports do not, as a rule, include photographs of the actual tone bursts, their relative importance and possible effect on the sound is noted by the reviewer in terms of pinpointing deficiencies in transient response at specific regions in the frequency range. Thus, high-frequency transient response may be adequate, while low-end transient capability leaves something to be desired. If careful listening tests confirm this, a comment will be included in the published report. When it does, that's your cue to concentrate—during your own listening tests—on such things as the attack of bass drums and timpani, the bowing of bass viols, while simultaneously listening for evidence of “muddiness” or lack of definition. If deficiencies are noted in the high-end transient response, listen for “fuzziness” in the reproduction of sibilant sounds, upper brass tones, and even the upper octaves in a piano solo.

Efficiency and Amplifiers The speaker reports in HIGH FIDELITY invariably recommend the amplifier power needed to properly drive the speaker system being evaluated—but this serves as a starting point rather than an absolute rule for your power requirement deliberations. To translate the published (and necessarily generalized) power requirement to the specifics of your own room size and listening preference, a knowledge of the relative efficiency of the system is still needed. Actually, an indication of speaker efficiency is implied in the frequency response curves already discussed. Those curves are derived with a standard electrical input to the speaker of 1 watt, and so the output levels on

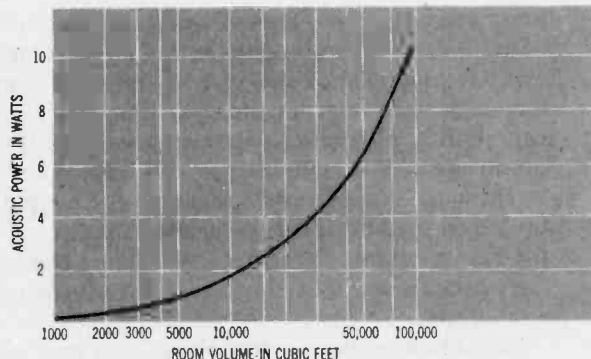


Fig. 4. Graph shows amount of acoustic power needed to produce 100-dB sound level in listening rooms of various sizes. Note that for other dB sound levels, the acoustic power requirements change. Specifically, for each 10 dB lower sound level desired, divide the acoustic power shown here by 10. For example: in a room that is 3,000 cubic feet in volume (length times width times height), the above graph shows that a sound level of 100 dB will be produced by 0.5 acoustic watt. To produce in this room a sound level of 90 dB, only 0.05 acoustic watt would be needed. For 80 dB, the acoustic wattage drops to 0.005, and so on. To estimate amplifier power needed, divide acoustic watts by speaker efficiency: e.g., 0.5 acoustic watt from speaker that is 1 per cent efficient requires amplifier capable of supplying 50 watts to speaker.

the dB scale of the graph provide a true indication of efficiency. For instance, an output level of 70 dB (caused by 1 watt of electrical input) represents a fairly inefficient speaker system. A speaker system that produces a sound level of 80 dB from the same 1 watt of electrical input is ten times more efficient than the one that produces only 70 dB of sound level. The acoustical (not electrical) power required to produce a 100-dB level in typical rooms of various sizes is plotted in Fig. 4. The cubic volume is simply the length by width by height of the listening room. If 90 dB of sound level is enough for your needs, you would reduce the readings by a factor of 10. If, on the other hand, you feel that you must have sounds at 110-dB levels, multiply the reading obtained for your room size by a factor of 10. A somewhat simpler approximation is to figure 1 acoustic watt per 1,000 square feet of floor space for a 100-dB sound level capability. Of course, to translate the acoustic power back into electrical power you would need to know the efficiency of the loudspeaker you contemplate purchasing. Here the frequency response curves of the report are used—bearing in mind that 10 dB represents a 10 to 1 ratio of power. Thus, if 1 electrical watt produces a sound level of only 80 dB in a room of approximately 1,000 square feet of floor (a large dealer's showroom is likely to have such measurements), it means that the *acoustic* output is 20 dB lower than our desired "100-dB level," or the efficiency of the system is $1/10 \times 1/10$ or $1/100$ th—or 1 per cent (a figure not uncommon with modern, air-suspension bookshelf-type speakers).

Whether you go through all these calculations or not, the final test will still be a listening test involving the use of an amplifier, whose power rating you think is adequate, coupled to the speaker you are

evaluating. If the speaker is capable of high sonic levels, as reported in the tests, but there is audible distortion as you approach such levels, you can be reasonably certain that the amplifier is overloading *before* desired levels of sound are attained—and you will then want to verify this "mismatch" by running the same speaker *from a higher-powered amplifier*. Most dealer showrooms are equipped to easily switch the speaker under test to any of several amplifiers as a driving source. These few additional A/B tests are well worth your extra time and effort, for there is nothing so frustrating as having selected an excellent speaker system only to find that the amplifier being used to drive it just doesn't have enough power output to do the job.

Power-Handling Capacity The transient-response tests using tone bursts serve another useful purpose: they enable the reviewer to suggest maximum power limitations for a speaker system. The older method—using continuous tones of ever increasing power—of determining how much power a speaker system can safely handle is invalid, since musical programming is unlike "continuous tones" and more like the tone bursts used in the transient-response tests.

For judging this performance characteristic we recommend that you be guided solely by the test reports. In other words, do *not* keep increasing the sound level in your own listening tests merely to find out how much a speaker system can take before its voice coil is destroyed or its cone structure is deformed. Such destructive testing may be worthwhile in an engineering laboratory (where one or more prototypes are actually driven to destruction in the course of a design program), but it would hardly be welcomed by an audio dealer.

Dynamic Range An important characteristic of loudspeakers that is not directly documented in the reports—but which often is inferred by the reviewer from related data—is that of dynamic range, the difference between the softest and the loudest sounds that you will hear when your system is finally put together in your home. The upper (or loudest) end of this dynamic range may well be determined by the highest sound level your selected speaker system can produce with reasonably low distortion, as tabulated in the test report. On the other hand, the lowest extreme (or the softest sound) you will be able to hear without masking caused by residual hum and amplifier noise will be governed more by the performance of your amplifier—not to mention the characteristics of a given phono pickup or tape deck. To gain some idea of a speaker's dynamic range, play a record at the loudest listening level you will want—and then lift the tone arm from the record. With everything (and everyone) else perfectly silent in the listening room, are you then able to hear hum and noise from the system? Is it at a bothersome level? If it is, then your lower limit of dynamic range capability is being diminished by amplifier limitations. Either the gain of the amplifier may be too high in terms of the efficiency of the speaker selected, or the amplifier's signal-to-noise ratio may be inadequate in terms of the speaker's own capabilities with respect to dynamic range. For this reason it is important that before purchasing a speaker system you should listen to it actually being driven from your own make and model of amplifier (or receiver). Today's program sources (FM, low-noise tapes, and discs) often contain useful dynamic ranges of 60 and even 70 dB. A residual noise level caused by amplifier problems may well reduce that available dynamic range by as much as 10 dB.

Your Own Listening Tests

While lab test results can help in choosing a speaker system, the lab measurements ideally should be related to listening tests. Conscientious equipment reviewers try to do so, but in the last analysis the "best ears" are your own. What matters most is how the speaker sounds to you, just as how a new garment fits you (regardless of stated size, or color, or style, etc.) really determines how well you will look in it.

Of course, it helps to know what to listen for. To begin with, it must be understood that a loudspeaker is essentially a translator, or—as engineers put it—a "transducer." It changes one form of energy (electrical) into another form (acoustical). In

so doing, it invariably adds and/or deletes something from the original. Because of the laws of physics there is no such thing as a "perfect speaker." There probably never will be. But the improvements and "refinements" in speaker design and manufacture over the years do result in systems that perform more accurately as translators or transducers than before.

One way of stating this from the standpoint of the listener would be to say that the better a speaker is, the more it gives you the feeling that you are not listening to a speaker at all, but rather to the program it is reproducing. Audio people refer to this feeling as "listening *through* the system" rather than *to* the system. They also refer to this quality as one of "transparency," the opposite being "coloration." Although many persons do not realize it, their own ears are well equipped to discern these qualities. It is surprising, perhaps, that so many—who firmly believe that "seeing is believing"—do not ascribe the same infallibility to their hearing. And yet the ear is one of the most sensitive and reliable "instruments" ever encountered: it can distinguish between subtle differences; it can be selective and hear one sound over another, or mask one sound under another; it encompasses a range of frequency response and dynamics scarcely met by the costliest of man-made test instruments. And it gets better with use: despite the well-known falling-off of sensitivity to extreme high frequencies as one gets older, the over-all response ability of the ear, the total hearing experience—particularly to music and "music-type information"—grows progressively more sophisticated. Listeners, like conductors, improve with age. By virtue of your own ear, you can verify your first impression and, more to the point, you can zero in on the final choice that often has to be made between two or three speakers which have impressed you equally favorably.

Although "transparency" and "coloration" can hardly be defined in clear-cut textbook fashion, they can be described in terms of the specific effects they encompass. Judging a speaker is rather like viewing a painting: from a few feet away you form a general impression; closer, you see how the individual brush strokes contribute to the total.

Sound Coloration: Speaker's Fault or—? Coloration of the sound, caused by severe irregularities of a speaker's frequency response (peaks of, say, 6 to 10 dB or greater anywhere along the spectrum) will show up as a tendency for the speaker to emphasize certain portions of the musical range. The highs may be too prominent with respect to everything else, or the mid-bass may force itself on your attention while all tones below and above it seem to

recede into the speaker box. Coloration also shows up as a speaker's favoring of one group of instruments over the others: the speaker may be prodigious, for instance, at projecting the characteristic guttiness of the string bass while at the same time masking the upper registers, or it may waft bold waves of brass tones into the room while lending the woodwinds and strings a too distant quality. It may favor the male voice (with a characteristic and false heaviness) while slighting female vocalists. And so on.

Of course, any of these effects might be inherent in a badly recorded disc or tape, and many of them—particularly extreme discrepancies in bass and treble balance—could result from poor room acoustics. For this reason, it is important to listen to the speaker playing material you know well, preferably your own fairly new recordings. As for the acoustic setting, you should try to evaluate a demonstration room in terms of how closely it resembles your own listening room. A room that is abnormally small is no place to assess speaker quality; it will tend to suppress or muffle the bass and probably bounce the highs around excessively. A room that departs in shape from the normal rectangle is also bad: if it approaches a cube in shape, it will cause most speakers to take on a hollow sound; if very long and corridorlike, it will introduce false resonances to the mid-bass. Any room that is heavily carpeted and draped will tend to tone down the highs; conversely, any room with prominent hard surfaces, such as glass show windows or shelves loaded with the metal chassis of other equipment, will tend to accentuate the highs.

Unless the demonstration room comes fairly close to simulating the acoustics of your own listening room, you should insist on listening to the same speaker in two or three different locations in that room before making up your mind. Or, ideally, you should try to get the dealer to agree to sell the speaker (or speakers for stereo) on approval—a week's time with them at home should be long enough to let you decide whether you want to keep them or return them for another pair.

What Do You Listen To? General impressions aside, another tack for the prospective buyer is to try to analyze the speaker's response in terms of its bass, midrange, and high-frequency output. Such analysis is best done with signal generators in addition to musical material. The signal generator can pinpoint specific areas of troubled response, reveal severe peaks and dips, indicate the low and upper reaches of response, reveal the speaker's "doubling frequency" (a bass frequency at which the speaker no longer can respond to the fundamental tone and

produces harmonics of it instead), and provide some information as to the speaker's dispersion characteristics (its tendency to beam tones as the frequency is raised). However, a signal generator is not as a rule a normal household item; and even if you owned one few, if any, dealers would permit its use during normal store hours. People come to hear music, not beep tones, goes the argument.

Well, yes. But there is music—and music. To serve as test source material, the music chosen should have some texture and weight. Music lightly scored (pops in particular) is apt to make a "joyful noise" on a much wider quality range of equipment than is symphonic music. It's no great shakes to reproduce (or to record, for that matter) simple-textured material which makes relatively little demand of the equipment and thus is of little value in assessing a speaker. A solo guitar, for instance, often is used to impress listeners with the transient response of a system, which is all right as far as it goes, but the real test would be a guitar playing against accompaniment: if the twangs are utterly clean *along with everything else*, then you can conclude something about the system's response. The real test is how well the speaker handles percussives when it also has to reproduce other, different kinds of sounds at the same time. Works scored for large ensembles and encompassing big jumps in dynamic as well as tonal range—operas and most symphonic works—actually comprise the best speaker test material.

Also useful are passages shared by a deep-voiced instrument, such as an organ or bass viol, with a high-toned voice such as a flute. Note too that instrumental groupings that have their own rich overtones structure—massed strings and woodwinds, for instance—tend to absorb distortion components, while "purer" instruments—such as the solo piano, flute, or horn—will be more revealing of distortion. The solo piano, in fact, is one of the most difficult instruments to record and reproduce well. The human voice is another: one of the touchstones of tonal purity is the male voice that sounds masculine but not "chesty" or with a hint of false mid-bass emphasis; another is the female voice that sounds lilting, "feminine" but not screechy. Thus, good recent opera recordings make excellent speaker test material: a poor system simply will not do justice to a soprano; a good system makes her a joy to hear, actually exhilarating. In general, when you find yourself listening not to the system but to the music, and you sense the goose pimples during certain passages, you can feel secure that you're hearing the real thing.

Popular music is not too valid for speaker test material since many pop records are made with

beefed-up midrange tones to make a soloist sound prominent. Similarly, many rock recordings have artificially boosted tones, especially in the mid-bass, that can give a false impression of a speaker's true ability.

Musical test material may not reveal to you the specific low-frequency response limits of a speaker, but you can tell by listening carefully to the music's bass portion whether or not the bass is generally satisfactory. Good bass does not necessarily mean the deepest bass, although ideally the deeper and cleaner the bass, the more natural the sound (assuming the midrange and highs are suitably balanced and full). There are, in any case, limits to how far down a speaker can go—limits governed by the design and cost of the unit. A speaker that can hit rock bottom, tonally speaking, generally will hit sky high in terms of cost. But rock bottom may not be within the scope of your taste, needs, or budget, especially when there are so many less than ultimate speakers that come fairly close and cost a lot less.

Good Bass Within its design limits (and any responsible engineer will admit that speakers do indeed have design limits), however, you should expect a speaker to sound clean. "Clean" bass is free of boominess, thumps, or a blurry indistinct effect. The bass notes are clear enough to enable you to distinguish between a string bass and a tuba. The bass drum, when struck hard, ideally should have a deep, somewhat "dull" and tight quality. A bass ensemble, playing way down and tutti, should provide a sensation of energy that you can almost feel as well as hear. The bass viol should growl rather than sound mellow. Timpani should sound something like real thunder, and you should be able to distinguish the tonal variation between differently tuned timpani. The low end of the piano keyboard should have a vibrant, almost rugged quality, and with good definition among closely spaced notes—what engineers call "being able to read the name on the keyboard." Finally, you want to be aware of possible intermodulation effects in which the powerful bass interacts with higher-pitched tones to cause the latter to blur or waver. A passage in which an organ or string bass plays together with high-pitched woodwinds is useful for checking this effect.

Good Middles and Highs Listening higher along the response range you still should be alert not only to peaks and resonances (they can occur anywhere along the frequency band to color the sound) but to the unique aspects of midrange and high-frequency sound. The treble portion of a speaker's

sound should have an open, full, well-aired quality. Poor dispersion, or a tendency to beam the highs, means that the highs will be most prominent when heard from somewhere directly in front of the speaker (response on axis will be noticeably brighter than off axis). In addition, the mid-tones may sound honky or "box-y" and/or the extreme highs will take on a "squashed down" tone, as if an invisible hand were compressing them. Outright distortion will be readily discernible as a kazoolike quality or nasality. Lesser amounts of distortion will show up as a "hard" or unnatural sheen over the sound.

In addition to the beaming effect, poor dispersion signifies phase distortion, a kind of tampering with the original time sequence of the elements of the signal that also can be responsible for lending the sound an overbright or hard feeling. When auditioning the midrange and highs, listen also for good transient response—a speaker's ability to respond crisply to percussives such as drum beats and rapidly plucked strings, especially when played against an instrumental background. Each note should sound distinct, with no blurring from the note before or to the note ahead. Another tip-off to transient response (of a pickup and amplifier as well as of a speaker) is the sound of record surface noise. An occasional surface defect should sound like a quick tick rather than like a prominent or extended rasp.

If an FM tuner is handy, tune to a point between two stations where you hear the characteristic rushing noise—white noise, as it's called. Listen for a few moments to the way in which the speaker reproduces this hash. If the sound is fairly subdued, rather like that of a shower running in the next room, the speaker probably has very little audible distortion in the treble and is dispersing the sound well. The brighter or harder this noise sounds, the more high-frequency coloration the speaker is adding to the signal and the more directional its projection of the highs. Many speakers characteristically sound bright on white noise when heard on axis, but more subdued off axis; this pattern is not ideal, but it is acceptable inasmuch as most home listening will be from a position decidedly off axis of the speaker, especially in a stereo setup where the main listening area is somewhere between the two "looking-out" axes of the speakers.

As for instrumental sounds in this frequency area, ideally you should try to recall what instruments (and voices) sound like when you last heard them live. Unfortunately, auditory recall is a very sometime thing, and for practical purposes such "A/B" testing in retrospect is next to futile. Realistically, the best you can do on this count is to listen

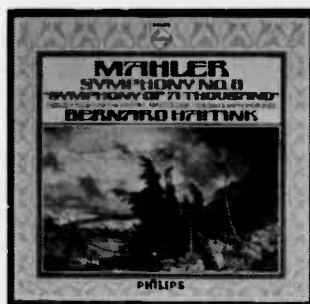
to the tonal blend of an ensemble even while trying to discern its individual sections and participants: the good speaker will present both sonic experiences equally well. It will have, as they say, its own "internal separation" without at the same time being "clinically analytic."

In the long run, listening for a good speaker is fairly akin to listening to music itself: you bring to both experiences a kind of ever-developing sophis-

tication and you get in return a deeply personal revelation. In both, you are listening for the singing strings, the plaintive woodwinds, the brazen brass, the definitive percussion. Eventually, you will recognize an authoritative speaker, even as you applaud an authoritative performance.

Some recommended recordings which we feel provide exceptionally good "speaker test material" follow.

Full orchestra and chorus; for highs, bass, transients, distortion, middle honk



MAHLER
Symphony No. 8, Concertgebouw
of Amsterdam, Haitink. Philips
6700 049 (two discs).



MOZART
Mass in C minor, K. 427.
Berlin Radio Symphony, Fricsay.
Deutsche Grammophon 138124.

These are tremendous recordings for sampling orchestra and chorus. Fortissimo tuttis put heavy strain on the ability of the speaker to maintain differentiation in loud passages. Listen to the fortissimo near the beginning of the Mahler and the soprano solo and choral passage near the end of the opening Kyrie in the Mozart. Do the massed sopranos stay as thrilling *voices*, or do they become shrieky or scratchy, or hard—the result of peaky highs? Do drums and cymbals have their natural sharp attack (transients)? Do low drums have satisfying weight, and the organ in the Mahler the

proper power, indicating good bass response? In the tuttis do you hear male voices, female voices, and the main orchestral instruments all individually? No known sound reproduction system will do this perfectly, but a poor system does it very badly indeed. Try to make sure your standards are not too low in this respect by hearing at least a sampling of your test records on an excellent system.

Also recommended:

BIZET
Carmen
Soloists, chorus and orchestra, Bernstein.
Deutsche Grammophon 2709 043.

ANY WAGNER OPERA (Karajan on DG; Böhm on Philips; Solti on London).

STRAVINSKY
Rite of Spring
L.A. Philharmonic, Mehta.
London CS 6664.

LONDON SYMPHONY, Bernstein.
Columbia MS 31520.

LONDON PHILHARMONIC, Haitink.
Philips 6500 482.

ELGAR
Enigma Variations
London Philharmonic, Haitink.
Philips 6500 481.

Transients and highs: percussion sounds

VARÈSE
Amérique.
 Utah Symphony, Abravanel.
 Vanguard S 274.



XENAKIS
 MétaStasis for Orchestra.
 French National Radio
 Orchestra, Le Roux.
 Vanguard C 10030.

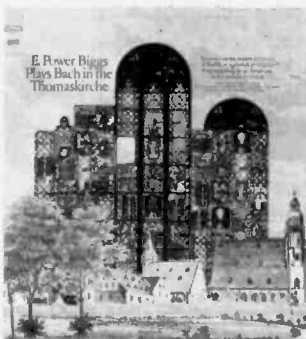
Each of these discs contains passages with an abundance of percussion instruments at work. Try the fortissimo about ¾ inch from the beginning of the Varèse or the *Stars and Stripes Forever* on the Boston Pops record. Wood blocks, bells, cymbals, triangles, and what not all make demands on transient response and on clear, crisp sound at the top of the highs. Cymbals are particularly revealing: they should “smash,” of course, but stay metallic and ringing, not papery or scratchy. It would be most helpful to hear one or more of these records on a very superior system first, because percussion may sound impressively sharp even when it falls short of its true quality.

The Boston Pops record is valuable not just for percussion, but also for general orchestral texture. Deutsche Grammophon has done a terrific job in Boston's Symphony Hall; the highs are exceptionally clean, wide and smooth.



WHAT THE WORLD NEEDS NOW
 (The Burt Bacharach/Hal David Songbook).
 Boston Pops, Fiedler.
 Polydor PD 5019.

Specials for bass



BACH
 Organ music. E. Power Biggs
 on the Thomaskircher
 Organ. Columbia
 KM 30648.



STRAUSS
 Also sprach Zarathustra.
 Los Angeles Philharmonic, Mehta.
 London CS 6609.

Also recommended:

BACH, J.S. “Die 6 Orgelkonzerte.”
 Karl Richter, organist
 Archiv 2533 170

NEW MUSIC FOR ORGAN: Music by Albright and Bolcom.
 William Albright, organist.
 Nonesuch 71260.

The organ is of course the natural instrument for a thorough low-bass test, and there are many good organ recordings. The Bach has the special virtue of using a baroque organ. The pedal notes have the wonderful, slightly snarly quality that gives us a ready criterion for low distortion. The dynamics in the opening D minor Toccata and Fugue are wide indeed—great as test material—and a lot of the bass has tremendous power. In those held chords in the Toccata, when the biggest pipes come in, do you hear great power at the very bottom? Listen most carefully when the pedal notes go up and down the

scale, as in the Fugue; does the speaker reproduce them all or does it drop some out of hearing? Listen too for the effect known as doubling, in which the deepest notes seem to lose their fundamental and seem to be dominated by the overtone an octave higher. The truer and more distinct the fundamental tone, the better the speaker. In judging bass, don't listen *only* to organ recordings, however. You will be listening to massed orchestral instruments—drums, cellos, etc.—most of the time, and the lowest organ notes are particularly difficult to record well.

The Strauss is a far-out test that will separate superb bass reproduction from the merely good. The soft opening is played by four instruments: a pedal note at low C (about 33 Hz) on the organ; the C an octave higher (about 65 Hz) on the contrabassoon; the C another octave higher on a kettle drum; and

the last two Cs played together on the bass fiddles. London has managed to get the organ note onto this record with superlative power and clarity. If your speaker is in the big bass class and your room is favorable acoustically, the organ will envelop you, assail you physically with a profound power. If your speaker is not quite in that class, you may know the organ is there but will hear mostly the buzz in the contrabassoon note and the tremolo in the double basses.

Remember, in making this test you are dealing with but a single deep-bass frequency. It does not tell you all you need to know about deep-bass response, and you might evaluate the speaker differently if the musical pitch were altered by as little as a whole tone. (If the speed of your turntable can be "tuned," you can easily check out this possibility.)

Some ultimates



MOZART
Violin Concerto, No. 4, in D, K. 218. Heifetz. RCA Red Seal LSC 2652.



BARTÓK
Quartet No. 2. Juilliard Quartet. Columbia D3S 717 (three discs).



LEONTYNE PRICE
"Prima Donna," Vol. 3. RCA LSC 3163.

Individually desirable characteristics should work together to produce a unified impression which is in itself a test. Take Price's marvelous singing. On a moderately good speaker it can be thrilling enough. What a speaker of the utmost refinement in middles and highs does by comparison is to remove some last "support"—coloration, if you will—so that Leontyne stands there *alone*, free in space, utterly true. All middle honk is gone, the mid-highs are smooth as glass, there is no roughness to make the sound edgy or hollow. The orchestra sounds absolutely true too.

Similarly, Heifetz' violin comes through wonderfully on fairly good speakers: It is recorded well up front, with plenty of pizzazz. Get good extended, supersmooth highs, and freedom from all honk, and the violin moves a little closer and into sharper focus, but ingratiatingly, sweetly, totally without hardness—just what a fiddle is like a few feet away. And the quartet music can be similarly indicative of the speaker's refinement at the top. It should leave behind all hollowness, all oversharpeness, and stand ultraclear but sweet.

How to Install and Locate Your Speakers

HAVING DECIDED on what speakers you prefer, the next item on the agenda is correctly installing them. This involves connecting them to the amplifier (or receiver) and finding the best location for each speaker system in your listening room. Some care is required for both chores.

The hookup involves running the proper wires to the speakers. The location problem is a bit more complex and logically divides itself into three main items (of which many listeners need concern themselves only with the first): best general positions for stereo; hints for "enhanced stereo"; and best general positions for quadriphonic sound.

The Hookup

At the amplifier (or receiver) end, your main concern is in making a secure connection to whatever terminals are provided. By secure we mean making certain that the strands of wire of each lead are tightly wrapped around each other. Loose strands can make contact with an adjacent terminal to cause the output signal to become "short-circuited."

If you connect the wires by simply stripping off some insulation at the end, it's a good idea to "tin" the exposed strands after twisting them. Tinning means applying a little hot solder to the ends so that they stay together. You also can use "spade lugs"—these are small metal connectors that have a sleeve that fits over the exposed wire and a U-shaped contact area. The usual size is No. 6. The sleeve should be crimped to the wire (tightened by pressure from a pliers) and, ideally, soldered too. Note that the "press-to-connect" type of terminals used on many receivers will not readily accept spade lugs; these terminals are best used with leads that have been stripped and tinned.

Some high-powered amplifiers have "binding posts" that consist of round plastic nuts fitted over threaded metal pins. Often, a binding post can accept a variety of hookup techniques—stripped and tinned wire ends, or spade lugs, or exposed wire ends fitted with "banana plugs." A banana plug is an insulated connector that fits over a wire end and mates with the center opening of a binding post.

Whatever method you use, it's a good idea to "code" the various speaker leads to distinguish between signal and ground (or "common") leads on each channel. Use small plastic labels attached to the leads, or different colored snips of adhesive tape, etc.

What Size and Type of Wire?

At first glance, it may seem that the most attractive wire to use for connecting speakers would be the flat twinlead "ribbon" commonly used for FM and TV antenna lead-in. This wire will lie flat under carpets, and it can be easily tacked behind cabinets. Actually, it is the worst wire to use for speaker hookups. It is too narrow in diameter or "gauge" for handling amplifier output signals, and in appreciable lengths it will reduce the total available signal.

The recommended wire to use for speaker hookups is "zip cord" which is electrician's jargon for lampcord, the familiar twin conductor wiring with insulation wrapped around each lead. This wire comes in different thicknesses, designated by gauge numbers. *The lower the gauge number, the thicker the wire.* Ordinary lamp cord is of No. 18 gauge. Thicker gauge versions come in No. 16, No. 14, etc. The gauge to use depends on the length of wire needed to connect the speaker system to the amplifier. The greater this distance, the thicker the wire

Thickness of Wire for Speaker Hookup (in gauge no.)

Speaker System Impedance (ohms)	Wire length, amplifier to speaker (in feet)						
	10	20	30	40	50	75	100
4	22	20	18	16	16	14	12
8	22	22	20	20	18	16	16
16	22	22	22	22	20	20	18

This chart shows the smallest-diameter (thickness) wire to use in amplifier-to-speaker connections to assure minimum signal loss. If in doubt, use the next thicker wire (next lower gauge number).

should be for optimum signal transfer and minimum loss en route. The accompanying chart can serve as a handy guide to this choice.

At the speakers themselves, observe the same care mentioned for the amplifier connections. Avoid loose strands of wire. Connect all leads securely. Be sure that the pair of leads from a given amplifier channel do indeed go to the speaker system intended to reproduce that channel. Do not confuse the ground lead from one channel with the signal lead of another channel.

A final point here has to do with phasing. When "in phase," speakers vibrate in step with one another. That is to say, their diaphragms move in and out together. However, if the two leads connected to one speaker system are reversed with respect to the other pair of leads, the two speaker systems will be "out of phase." The low-frequency response will be degraded, and the stereo image—especially the center stereo information—will be ill-defined. Sometimes soloists will seem to "wander" and in general you lose a sense of "firmness" in the stereo presentation.

To keep speaker systems in phase with each other when hooking them up, the wire-coding dodge mentioned earlier will help. Be consistent in how you connect the various leads. For instance, most zip cord has a slight "ridge" or molding, or sometimes a marking, along the insulation of one of its two leads. Decide that the lead with such identity is to be used for either "signal" or "ground" and then stick to that rule throughout.

If you are uncertain, after the hookup, about whether or not the speaker systems are in phase, listen to them playing a mono signal (switch the amplifier or receiver to mono mode). Stand in front of, and midway between, the two speaker systems. If you hear a well-defined sonic image but it is somewhat to one side, it could be that the channel balance is off; this should be corrected by the balance control on the amplifier or receiver. If, however, you can't tell where the sound is, chances are the speakers are out of phase. In that case, turn off the power, reverse the two leads going to either of the speaker systems, and repeat the test. The hookup

that gives you the best-defined sonic image will be the correctly phased one.

Best Positions for Stereo

A very general rule is to locate each speaker system so that it becomes the end of an equilateral triangle with respect to the main listening area. This rule can be violated to some degree, of course, but there are limits. If the speakers are too close together, you will lose some of the stereo effect. If the speakers are too far apart, you will hear exaggerated channel separation or "Ping-pong" sound.

In an average rectangular room, you can enjoy stereo whether the speakers are placed against the long wall or the short wall. But note that generally the speakers will provide stronger bass and smoother highs when they "work" into a long dimension—this way there is less chance for standing waves and excessive "bounce" to develop in the reproduced sound.

To a great extent, the recent design trend to "omnidirectionality" in speakers helps the distribution of sound with somewhat less critical attention to exact placement in a variety of rooms. If you use such speakers, make sure that you place them to take advantage of their dispersion pattern; the instructions for positioning them found in the owner's manual should be followed carefully.

The closer to an adjacent surface (floor, wall, or ceiling) you install any speaker, the more apparent bass it will furnish. In some rooms, however, trying to get more bass this way can prove frustrating. You may find, for instance, that the speaker is exciting room resonances that are falsifying the bass, making it sound too heavy. If so, move the speaker away from the wall, etc., and settle for less, but cleaner-sounding, bass. The major exception to this advice is, of course, a corner-horn system which depends on adjacent walls to serve as extensions of its own horn structure. Such a system must be placed in a corner.

Any speaker, ideally, should be located in a relatively "live" portion of a room and look out at an

acoustically softer portion. Not recommended, for instance, is placing speakers near heavy draperies. Place the speakers as far away as possible from draperies.

The speaker system, for each channel, should ideally look into the same kind of acoustic environment: symmetry here is the keynote. A setup, for instance, in which one speaker faces a large undraped window and the other a long corridor will be difficult to balance for stereo. Chances are one speaker in such an installation will always sound a little (or a lot) different than the other. The trouble is not that the manufacturer couldn't make two identical models; it's that you have loaded them to the room in utterly different ways. And, of course, you would not place a speaker behind a large item of furnishing any more than you'd block an air conditioner with an overstuffed chair.

Most rooms, with a normal complement of furniture, carpeting, window hangings, bookshelves, and so on, do turn out—acoustically speaking—to be within a broad average range between “dead” and “live,” or overabsorbent of sound and overreverberant respectively. However, if the room is predominantly “live” or “echoey,” you can add upholstered furniture, heavier draperies, or carpeting to tame it down. Sometimes ceiling tiles help (especially in a playroom that has been carved out of a basement or part of a garage), but use these carefully. They deaden the sound quite a bit and if used excessively they will muffle the highs and unbalance the best of speaker systems. For this reason they are not recommended for use in a normal living room in which you also want to enjoy good stereo.

The most difficult shape of room for good sound is the one with dimensions approaching a cube (length, width, and ceiling height all the same or nearly the same). Deliberately offsetting these equal dimensions can help—floor-to-ceiling built-in shelves along one wall or heavy draperies at one end might do the trick. If all else fails and the room sounds boomy no matter what, you might try one dodge that has been reported as being effective. If there is a sofa in this room, get a sheet of ½-inch or thicker plywood that is just a bit shorter than the sofa and not quite as high as its back. Tack a layer of fiber glass to one side of the plywood, and then position it behind the sofa. It won't show, and it may help “flatten” the room's response.

Getting Into Stereo and Room Acoustics

The acoustical character of your listening room has a definite effect on how any speakers will sound in that room. What follows is a detailed guide to this

often difficult relationship.

A prerequisite to evaluating the sound of stereo is a rudimentary knowledge of the frequency spectrum. It is divided into three segments. The *bass* extends from the deepest audible tones (about 20 Hz) to about 200 Hz (roughly, three notes below middle C). The *midrange* extends from here to about 3,000 Hz, which is just below the top range of the highest musical instruments, the piccolo and the organ. The *highs* extend from this point to the highest audible fundamental sounds (just below 20,000 Hz) and for at least an octave above to about 40,000 Hz. This last segment is a most important one since it contains the overtones. Every musical tone consists of a fundamental tone that is the one we are conscious of and a series of overtones that sound so softly that they cannot be distinguished as such but instill a unique timbre to the sound. It is only through the particular loudness pattern of the overtones that we are able to distinguish an oboe from a flute, for example.

In order to evaluate your stereo system, you must be able to distinguish the three segments of the frequency spectrum by ear. First, the bass. Very low bass (below 60 Hz) is *felt* more than heard. Try to remember the last time you heard an organ in a church or concert hall. Do you remember the awesome feeling of low bass tones of the organ, which seem to shake the very foundations of the building? Do you remember *feeling* the vibrations, particularly in your stomach? If not, try to become conscious of the rumble while riding on a subway or standing in a subway station while a train is approaching. Such rumble is quite similar to very low musical tones insofar as frequency is concerned. The upper bass region from about 60 Hz to 200 Hz imparts to music a richness and roundness of sound. If accentuated, however, this region can cause the sound to become woofy and thick, with an overresonance that seems to spread itself throughout a room annoyingly.

How do you distinguish midrange and highs? Listen to the sound of a very small radio or television set. Its little speaker and limited electronics will be unable to reproduce any bass to speak of or any highs beyond 5,000 Hz. What remains is practically all midrange—a sound lacking the warmth of the upper bass, the virility of the lower bass, and the sparkling, crisp, and lifelike sound of the highs. A system lacking highs will produce a dull, lackluster sound with little realism. To judge the reproduction of highs, pick one of the recordings recommended at the end of this article and listen to instruments such as the cymbal, bells, or triangle. Do they appear with realistic sparkle and brightness, or do they sound dull? Also listen to a recommended spoken-word recording and see if the natural sibi-

lance of speech is being reproduced. Overbrilliance is easily spotted by excessive sibilance.

It should be apparent by now that frequency response and sound quality are interrelated. Any deviation in frequency response (an increase or decrease) in any portion of the frequency spectrum will (in a predictable way) affect the quality of sound.

A perfect stereo system does not exist. Each system produces inherent deviations which impart a specific coloration to everything played through the system. Each component will contribute some degree of frequency distortion. The shortcomings of components must be accepted, but we can learn how to choose the best components for a particular acoustic environment. This brings us to the truly *final* component in the chain—the room. A stereo system does not exist in a vacuum. Although it has a specific and measurable frequency response, it will change color like a chameleon from room to room. The same applies to the sound of your voice, a particular symphony orchestra playing in different concert halls, or any sound source. The influence of the acoustic environment is enormous. The *shape* (rectangular, square, irregular), the *dimensions*, the *placement of furniture*, the *nature of the materials* present in the room, all affect the sound. Furthermore, the chain of electronic components (carefully matched to each other) must also match the *final component*—an acoustic one.

In order to experiment with room acoustics, we must learn to recognize deficiencies in the frequency spectrum, resonances, sonic “holes,” and relative dryness or reverberance in the various parts of the spectrum.

We have described how to recognize bass, midrange, and highs, and we will next discuss room reverberation and resonances. But before we do, let us touch on what I like to call the “musical relativity theory.” It answers in very simple terms the basic questions of how much bass, how much midrange, how much treble, and how much reverberation is the correct amount. It’s all relative. No two conductors balance the low, middle, and high instruments of the orchestra exactly alike. Not everyone prefers the same concert hall or the same stereo system. The balance of the three frequency ranges and amount of reverberation are matters of personal taste. There are no absolutes. However, gross deviations from the way music is written to sound are simply incorrect and not to be tolerated. If the sound is so bright that the bass is hardly audible, you will hear the music poorly balanced. The same is true for the reverse condition—overpowering bass and insufficient treble, and so forth. If there is an excess of reverberation, the music

loses clarity—you cannot hear fast-moving notes clearly.

The relativity theory also works in this respect: When manipulating or adjusting the frequency spectrum by means of tone controls or speaker placement, you can never gain anything without losing something. For example, increasing bass doesn’t merely have the effect of increasing bass but also of decreasing treble (in a relative way). This can be best understood graphically. A relatively well-balanced sound spectrum would be described as having a flat frequency curve. Increasing bass would cause the curve to deviate (Fig. 1). Since

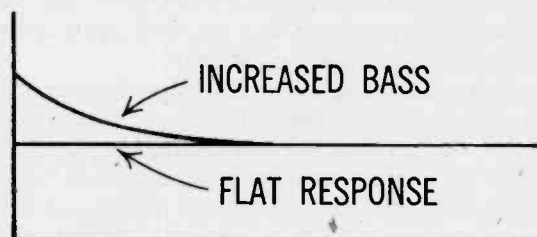


Fig. 1

the ear (the brain) does not have exact auditory memory for sound, it does not recognize that the second sound spectrum contains the same amount of treble (in an absolute way) as the first one. It now simply hears an imbalance of treble vs. bass—more bass than treble, less treble than bass. This is musical relativity.

Personal preferences regarding the frequency spectrum should be judiciously exercised within the range dictated by musical considerations. It is important to learn how to control room acoustics and equipment to achieve your wishes. Perhaps you prefer a bigger-than-life sound. Perhaps you are more of a purist who wants to hear the natural sound of an orchestra in a concert hall as he remembers it. On the other hand, you might prefer a more powerful bass, or a more brilliant treble than you would ever hear at a live concert, or more reverberation than in your favorite hall. There are some effects we are sure you will *not* like, however: boomy or woofy bass, annoying resonances, sonic “holes” produced by standing waves, screechy, hissy highs, a bottomless sound lacking warmth, a hollow sound lacking midrange, a lackluster sound deficient in highs, an indistinct, inarticulate sound caused by excessive echo, or a small, dry sound caused by insufficient reverberation.

Let us start our experiments with the intention of getting the most out of our present equipment without changing any components or switching to another room, but considering the possibility of

changing speaker placement, altering the acoustics by simple maneuvering of furniture, and adding or removing rugs and drapes.

Relative dryness or liveness of your listening room The materials present in a room and the placement of the furniture greatly affect the acoustics. The liveness or dryness of a room (in the three frequency ranges) is our primary concern. What, exactly, do we mean by liveness or dryness? Let's find out. Go to that room in your apartment or house which is most amply filled with rugs, heavy drapes, and stuffed furniture. Make believe you are Ezio Pinza and belt out *Some Enchanted Evening*, making sure to listen to the quality of your voice. Do it several times until you really hear your own voice as a listener would. Now proceed to your bathroom and sing the same song. What a difference! Your voice now sounds bigger, more resonant, effortless, and round. (Don't get any delusions; everyone's voice sounds great in a bathroom.) Needless to say, your bathroom is relatively live, and the other room relatively dry. Your bathroom reflects more sound than it absorbs, and the other room absorbs more sound than it reflects. The reflection of sound causes reverberation or echo. While necessary and important to the sound source, echo in excess becomes very annoying. Should you place your stereo in a completely empty room, the sound would bounce around with such liveness and resonance that much of the detail of the recorded sound would be swallowed up (unless the room happens to be covered with acoustic tile or other sound-absorbing materials). In the other extreme, a room loaded with sound-absorbing items such as heavy curtains, thick rugs, stuffed furniture, and with little or no empty wall space, will cause the identical stereo system to sound small, lackluster, and with unnatural dryness.

Now that you have carried out the first part of this experiment, repeat it in your listening room. If your voice sounds small and unpleasant, you have a rather dry room. If it sounds resonant and pleasing, you probably have a good listening room. Should it sound somewhat the same as in your bathroom, you have an overreverberant room which will obscure details of the music. But the real test is a full-frequency orchestral record. Play some music that has notes in rapid succession to see whether one note is blurred into another. Don't, however, base your judgment on one record alone—you cannot take for granted that each and every record is *recorded* with the utmost clarity. Be sure to select passages in the three frequency ranges. Your room might very well be adequately reverberant in one range and deficient or over-

abundant in another. For this test I recommend Bartók's Concerto for Orchestra, with the New York Philharmonic conducted by Pierre Boulez (Columbia M 32132). Special arrangements were written for each section of the orchestra so that the full capabilities of the instrumentalists and the complete ranges of all the instruments could be displayed. Another excellent way to check your sound is to use an organ recording.

Evaluating the room's reverberation, resonances, and nulls In evaluating the reverberant qualities of your room, you will have to take into consideration the phenomenon of standing waves. Briefly, a standing wave is produced by a sound wave whose length is twice that of any room dimension, which causes that wave to be reinforced via reflections. These standing waves or resonance frequencies exist for each dimension of a room. They also form at all multiples of these fundamental resonances. Each room, therefore, will produce resonances at many frequencies depending on its dimensions. These resonances are beneficial if they are evenly spaced throughout the frequency spectrum and of uniform intensity. By intensifying sound they decrease the amount of acoustic power needed. However, when there are one or more isolated resonances of great intensity, the effect is quite annoying and interferes with listening enjoyment. These are easily spotted. They seem to pervade the whole room rather than merely emanating from the speakers. Standing waves also produce pressure nulls in the room where the particular frequency is somewhat cancelled out.

The quickest way of finding the resonances of your room is to use a frequency test record which contains a sweep tone. Such a tone "sweeps" all the frequencies from around 20 Hz to 20,000 Hz. Resonances will be quite obvious, and since most sweep tones contain marker signals for every 100 Hz, you will be able to note the approximate frequency of the resonances.

There are two ways to deal with annoying resonances. One way is to increase room absorption, the other to move the speakers to a location where they will not stimulate a particular standing wave. Play the sweep tone and listen for the offending resonance along the wall at which the speakers are placed. You should be able to find a spot where the resonance is minimal. This will generally be about halfway up the wall and perhaps one third to a quarter in from the corners. The absorption technique decreases the intensity of the standing waves and assures a more even spread of sound pressure throughout the room. At the same time, the average loudness of the music decreases and the sound

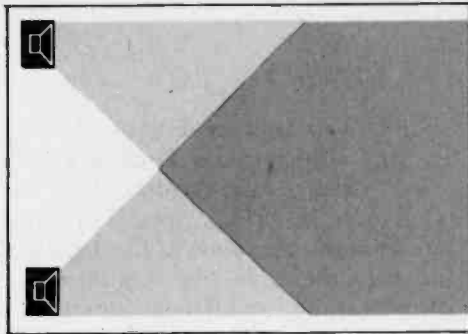


Fig. 2

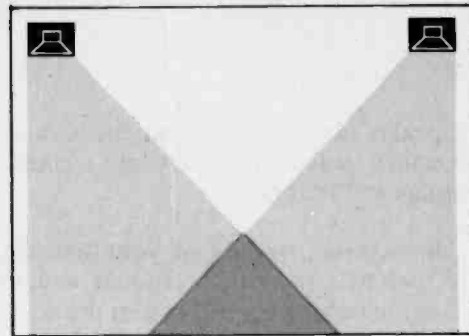


Fig. 3

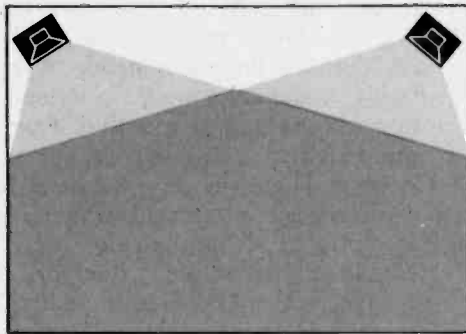


Fig. 4

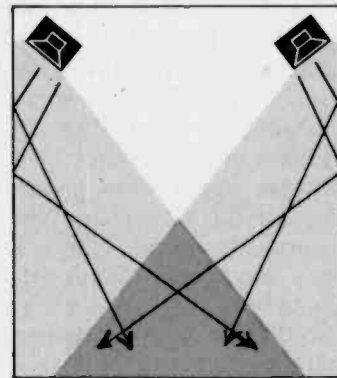


Fig. 5

deadens considerably. Resonance-damping below 100 Hz is difficult to well-nigh impossible for practical purposes. Above this frequency, damping can be accomplished by the use of rugs, upholstered chairs and sofas, and soft drapes.

It can be seen that the control of reverberation and resonances is interrelated. Ample reverberation is usually more pleasant, but increases any tendency toward resonances that exist in the room.

Speaker placement in relation to bass, separation, and shape of room Bass response in a room is strongest when speakers are placed in corners on the floor (or up against the ceiling). In this case, the walls help propagate the low-frequency waves. Bass can be minimized by taking the speakers off the floor or moving them away from corners, of course.

Since liveness means more reflection, it also means less separation. By separation we mean the preservation of the two stereo channels as distinct sound sources emanating from two distinct locations. If there is a great deal of reflection, the two channels become somewhat homogenized before reaching the ears of the listener and lose some of their identity. In a very live room, the speakers should be placed further apart. Conversely, in a very dry room the speakers should be placed closer together in order to prevent a "hole-in-the-middle" effect: a lack of blending between the two channels

which prevents the synthesizing of the many "ghost channels" that should fill the space between the speakers.

Should it be impossible or undesirable (for extramusical reasons) to control the dryness or liveness of the room, you might follow the suggestions for speaker placement shown in Figs. 2 and 3. Note that when placing speakers widely apart in a live room, more clarity is sometimes obtained by angling the speakers inward for more direct sound. Otherwise one may be out of range of the dispersion of the tweeters which operate at a narrower angle than midrange or woofers (Fig. 4). Conversely, more reflected sound can be obtained in a dry room by angling speakers outward (Fig. 5).

At times a center-channel speaker is desirable. For example, if you have a long but narrow room and want to place the speakers against the long wall, the wide separation between speakers would make a center speaker desirable (Fig. 6). The arrangement at the right is probably more satisfactory. There is increased listening area and more direct and intense sound due to the angling of the speakers. L-shaped rooms can be handled as shown in Fig. 7.

Speaker placement in relation to highs The distance between speakers and their position relative to each other (angled or not) affects the dispersion of the highs. Tweeters have a much narrower angle

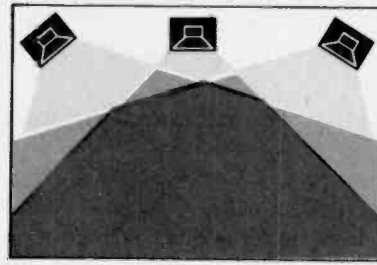
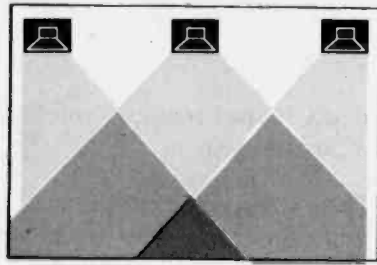


Fig. 6

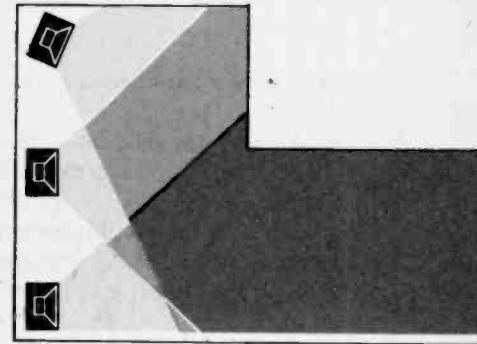
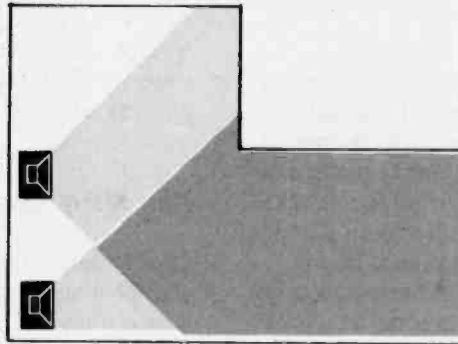
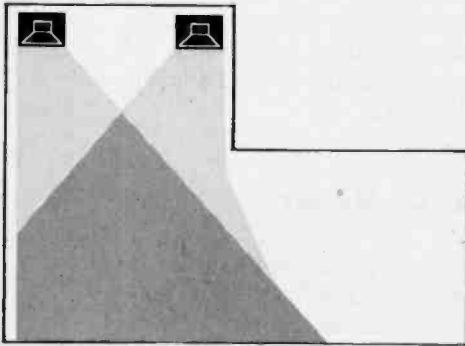


Fig. 7

of dispersion than midrange or bass speakers. The positioning of the speakers must assure adequate highs from both speakers. Map out the general area which is to be used for listening and then check to see whether every spot in that area receives adequate highs from each speaker. Angling speakers in or moving them closer together will pull more highs into the listening area.

The use of tone controls When all experimentation regarding furnishings and speaker placement has been completed, further adjustments can be made through the use of tone controls. Because tone controls are designed to make rather gentle changes over a major portion of the frequency spectrum, they have limited efficacy.

For example, most bass controls affect the response up to 500 or even 1,000 Hz and they should really be called "bass/midrange" controls. Solving any real problems due to room acoustics via tone controls is doubtful. They *can* somewhat compensate for deficiencies in speakers or amplifiers. Again, experimentation is necessary.

How to upgrade components and match them to your room Do you have enough power? This depends on three factors: the acoustic character of your room, the efficiency of your speakers, and the loudness with which you like to listen. More power is needed for a large room, an acoustically dead

room, less efficient speakers, and for loud listening levels. Less power is needed for a smaller room, an acoustically live one, more efficient speakers, and for lower-volume listening levels.

Which speaker/amplifier combination is best for a particular room? If your room has a tendency toward low-frequency resonances, you would be wise to invest in a good transistor amplifier with a high damping factor. This kind of amplifier delivers a tight bass signal free of resonances. (Resonances can be produced by amplifiers and speakers, as well as by rooms—these are electronic rather than acoustic resonances.) You should also buy a speaker that minimizes bass resonances. Any acoustic suspension speaker should do the trick, but there are also excellent speakers operating on other principles that offer a tight, clean bass.

The efficiency of the speaker, the desired loudness, and the liveness of the room determine amplifier power needed. Your sensitivity to distortion will also play a role. If you are more sensitive to distortion, you will need more amplifier power. The transients caused by a percussive piano, a cymbal crash, or a xylophone demand sudden quantities of power. If there is no reserve, the result is distortion.

The purchasing of speakers is particularly tricky since they will never sound the same in your home as they sound in the dealer's showroom. The only safe way is to buy speakers with an exchange privilege and a trial period of a day or two during which

you can find out how well they sound in your particular room.

As to cartridges in relation to your room, you should be aware of the fact that they have tendencies toward resonances in various parts of the spectrum. Most commonly, they produce a resonance in the area of 8,000 to 12,000 Hz. If your room tends to be dull, you need not worry about such resonance unless it is really excessive. The ability of the cartridge to reproduce bass cleanly or with moderate resonance again should be taken into account in relation to your room resonances in this part of the spectrum.

Choosing a room Since the effects of materials and furnishings have already been discussed, we need only consider the dimensions and shapes of rooms. These have a great bearing on the pattern of standing waves that the room will produce. Ideally speaking, no single dimension of the room should be less than ten feet, no dimension should be a multiple of any other, and no two surfaces should be parallel. The worst possible case is a perfect cube. Since ideal conditions will seldom be met, keep in mind the following principles. Small rooms cannot reproduce low bass adequately since the length of the waves of very low notes will be greater than any dimension of the room. For example, the first note of *Also sprach Zarathustra*, a low C, is 32 Hz, with a wave length of thirty-five feet. A 40-Hz tone has a wave length of about twenty-eight feet. Since music generally does not go deeper than 32 Hz, a thirty-five-foot room is all you will ever need. Bass reproduction decreases as the dimensions decrease. A small room, such as an 8 x 10 x 12 is unable to do justice to bass below 100 Hz, for example.

Since there are very few rooms with ten-foot ceilings and thirty-five-foot lengths, let us discuss the possibilities for conventional rooms with eight-foot ceilings. Height, width, and length ratios have been worked out for small, average, and large rooms.

	Small Room		Average Room		Large Room	
	ratio	dimensions	ratio	dimensions	ratio	dimensions
height.....	1	8'	1	8'	1	8'
width.....	1.25	10'	1.6	12' 9"	1.25	10'
length.....	1.6	12' 9"	2.5	20'	3.2	25' 7"

If you are lucky enough to have a ten-foot ceiling, look for the dimensions 10' x 12' 6" x 32'. Stay away from the dimension of 17' 6" since this will emphasize any inherent 60-Hz hum.

As for the shape of your listening room, an irreg-

ularly shaped room is sometimes better. Don't be afraid to try it.

In conclusion Experimentation, involving time and effort, is the only way to arrive at good reproduction of recordings at home. But do not expect to hear music at home with the same realism as in the concert hall. Recording, not unlike film-making, bears only an oblique relationship to reality. Both media can and do surpass realism. Learn to appreciate the medium of recording. You will hear sounds that you have never heard before and subtleties of balance unheard of in the concert halls. You will feel the excitement of controlling the sound yourself via experimentation and the upgrading of your equipment.

How Many Speakers for Stereo?

One widely proposed and often-tried solution to the problems of room acoustics vis-à-vis good stereo sound is the use—in the same room—of more than the two speaker systems nominally required. Only two channels are reproduced, but they are beefed up by auxiliary speakers. In general there are two methods of doing this. One is to use a "center fill" speaker. The other is to use "flankers."

The center-fill speaker reproduces a combined left-channel and right-channel signal ("A plus B"). It helps fill a sonic "hole in the middle" between widely spaced left- and right-channel speakers and thereby creates more of a "wall of sound" effect.

The flankers are simply additional speakers paralleled to the regular left- and right-channel speakers. They help spread the sound when the original pair are too closely spaced. Again, they help create a wall-of-sound effect and—if they are located along the sides—they can also add a lifelike ambience to the reproduction. Sometimes this effect, on ordinary stereo, gets surprisingly close to quadraphonic sound.

Details on these advanced hookups are given elsewhere in this book. But briefly, here are some relevant pointers.

The extra speakers for such installations need not be as fine performers as the two main units—they will not, after all, be carrying the main burden of program reproduction, only lending a helping hand. In any case, before launching into this kind of sonic adventure, check your equipment (receiver or amplifier) to make sure it can handle the added load. Some sets are not recommended for simultaneously driving more than one speaker system per channel. Others are—and in fact many late models actually provide the connecting terminals for extra

MEANS OF CONTROLLING ROOM REVERBERATION AND RESONANCES

To Increase Reverberation

Create more reflective surfaces. (Only hard surfaces of glass, wood, plaster, etc., reflect sound efficiently.) Remove absorptive surfaces.

Try these various steps one at a time and keep checking the sound of your stereo with a full frequency musical composition such as *Also sprach Zarathustra* by Richard Strauss. (The opening note is around 32 Hz.)

- 1) Remove a couple of small scatter rugs, exposing the hard floor.
- 2) Open drapes, exposing the glass surfaces of the windows.
- 3) Close doors, thereby creating additional wood surfaces.
- 4) Remove unnecessary furniture to expose more wall and floor space.
- 5) Remove any tapestry or ornamental cloth from walls.
- 6) Substitute contemporary furniture featuring wood, glass, plastics, for stuffed chairs and couches.
- 7) Use ornamental objects with hard surfaces—vases, sculpture, glass framed pictures.
- 8) Remove all rugs, if necessary.

To Decrease Reverberation

Create more absorptive surfaces. Remove reflective surfaces.

- 1) Place scatter rugs on floor. For damping at low frequencies of about 100 Hz upwards, it is necessary to use heavy carpeting with padding.
- 2) Install heavy, soft drapes and close them. (About half as effective as heavy carpeting with padding.)
- 3) Open doors and windows (effective down to about 350 Hz for average-size doors).
- 4) Use upholstered chairs and sofas (quite effective down to low frequencies).
- 5) Add tapestries, oriental rugs, or cloth to one wall, preferably opposite to speakers (this will affect the midrange and highs).
- 6) Install thick, wall-to-wall carpeting.
- 7) Install acoustic tile on ceiling (effective for highs and midrange—little effect below 1,000 Hz).
- 8) Place a room-divider-bookcase with a burlap-covered Celotex back somewhere near the center of the room.

speakers, as well as a front-panel switch that lets you turn them on or off at will. This arrangement not only permits you to experiment with multi-sound-source techniques, it also makes it very convenient to run extension speakers for stereo in another room. Indeed, why shouldn't someone preparing a gourmet dinner in the kitchen be able to hear Glenn Gould as well as you, sprawled out in the living room?

To use extension speakers in another room, or additional speakers in the same room, the amplifier must have enough power to drive them all and enough stability to withstand the different loading conditions of extra speakers. If you're in doubt, or if your owner's manual makes no mention of this, query your dealer or the manufacturer.

The use of extra speakers, by the way, is a big

reason for some enthusiasts' preferring—despite the undisputed excellence of today's combination units—completely separate preamp and power amplifier, or that type of combination amplifier which permits you to “go into” the circuit, so to speak, between its preamp and power amp sections. With such equipment, you can bridge the preamp output (connect it to more than one load simultaneously) so that it feeds not only the stereo basic that is driving your two regular speakers, but also drives a separate amplifier which in turn is driving its own speaker or speakers. This elaborate setup is costly and takes up more installation space, but it sidesteps all possible problems of amplifier power and loading, and it does provide an optimum match for additional speakers.

Some separate “deluxe” preamps make it easy—

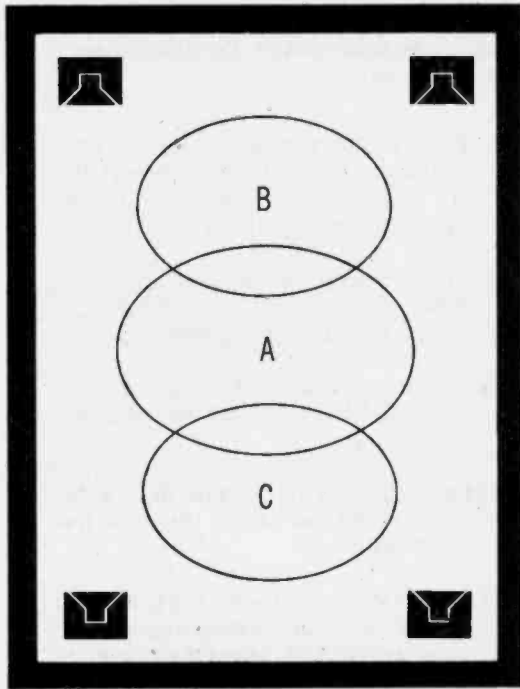


Fig. 8

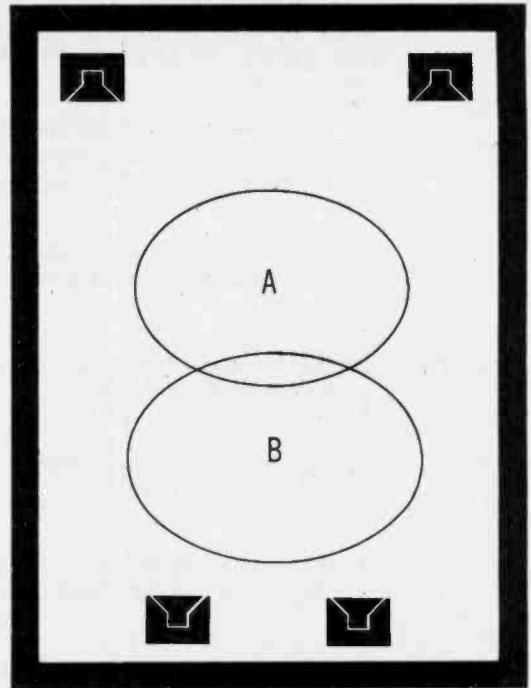


Fig. 10

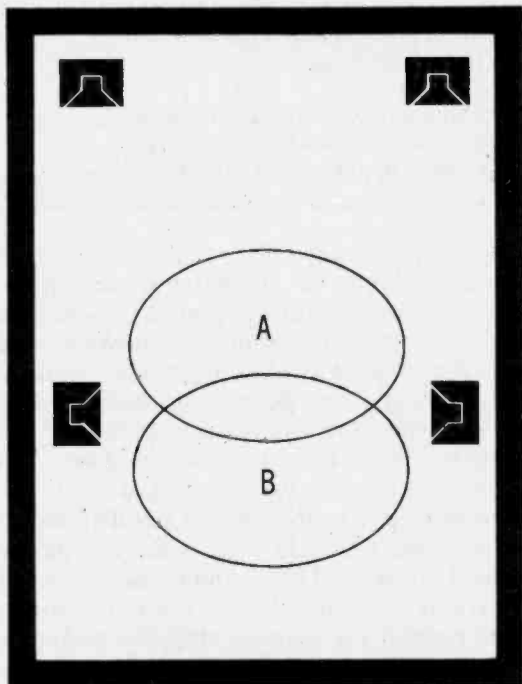


Fig. 9

"Standard" four-speaker arrangement (Fig. 8) is ideal but may not be feasible in many rooms. "A" designates maximum quadraphonic effect area. "B" area emphasizes up-front stereo effect, provides less prominent signal information from rear speakers. "C" area lessens normal stereo effect, emphasizes rear-channel signals.

In room similarly shaped to that shown in Fig. 9, this speaker arrangement may prove very useful. Listening area "A" provides maximum surround-sound effect and may be preferred for some new pop albums recorded with primary signals on all four channels. "B" area provides less obvious rear-channel information but affords very spacious ambient effect you may prefer for more traditional music.

Least satisfactory arrangement (Fig. 10) is to place the rear speakers a good deal closer together than the front speakers. This reduces effective quadraphonic area to "A" but still permits fairly large area "B" for enhanced ambience on traditionally recorded material. If latter effect is all you want, it can be achieved by using the simple Dynaco Quadaptor hookup which permits driving rear speakers without the need for additional amplifier.

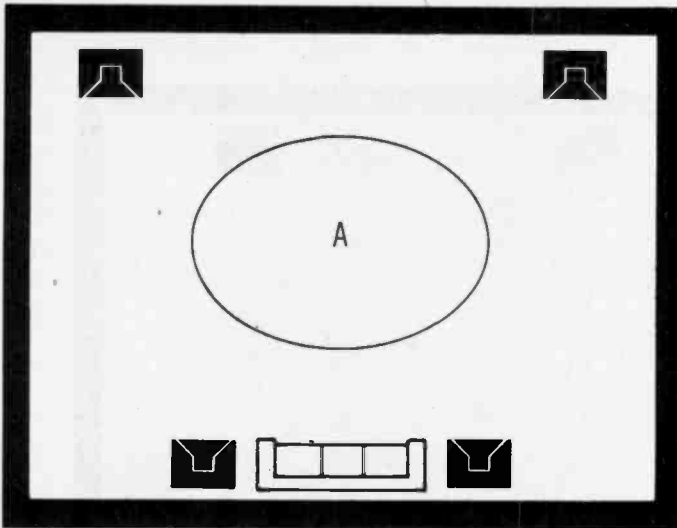


Fig. 11

In room (Fig. 11) where main (front) speakers are on long wall to provide very broad stereo "front," placing the rear speakers too close together (a typical plan may be to flank the sofa with them) limits the maximum quadruphonic area to "A." Listening from the sofa this way may not provide the best four-channel sound unless level control for rear speakers is carefully adjusted.

In room similarly shaped (Fig. 12) rear speakers may be placed farther apart than front speakers. This optimizes area "A" for quadruphonic effect, while area "B" tends to emphasize rear-channel information. Again, this can be corrected by using level or balance controls on quadruphonic adapter or amplifier.

Again (Fig. 13), in room in which main speakers are on long wall, rear speakers may be added along side walls. This will enlarge quadruphonic area to "A" as shown, while "B" area continues to emphasize original up-front stereo effect.

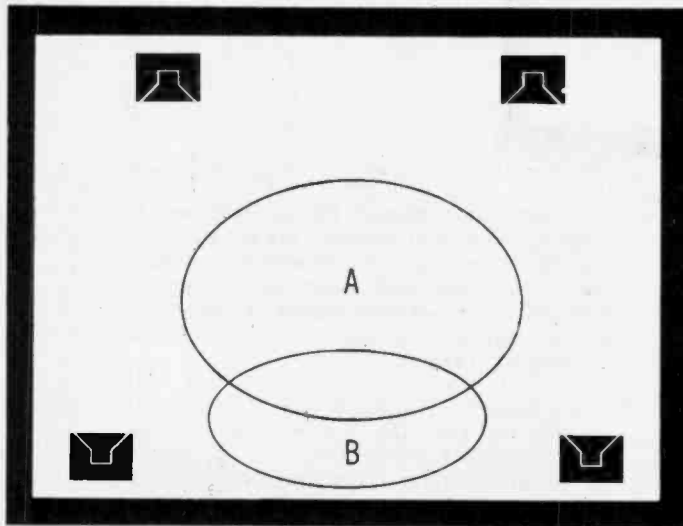


Fig. 12

they come with dual sets of signal outputs for each channel, which can drive two separate stereo basic amplifiers (or one stereo basic and another stereo control amplifier) at once. The output of your main speakers is controlled by the volume control on the system's preamp. The level of the added speakers can be controlled by input level adjustments on that second basic amplifier, or by the volume control on the second control amplifier. If no signal-level controls for the added channels are present, it would be wise to use speaker "pads" (external level controls) in the lines feeding the extra speakers. The point is, you want those extra speakers to beef up the stereo spread, but not to overwhelm your main speakers. Level controls will enable you to get

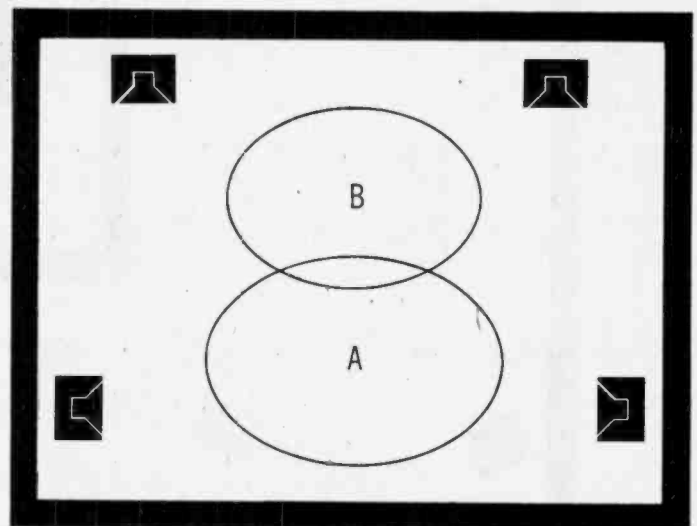


Fig. 13

just the right shading of volume relative to all the speakers. This way you can balance everything precisely to suit different kinds of program material, the acoustics of the room, and your own listening tastes.

Special Setups for Quadraphonic Systems

Most of the diagrams offered so far by the sound industry to show how the four speakers of a quadraphonic system are to be placed follow a common pattern. The four speakers are located so as to form the corners of a rectangle and they are designated as LF (left front), RF (right front), LB (left back),

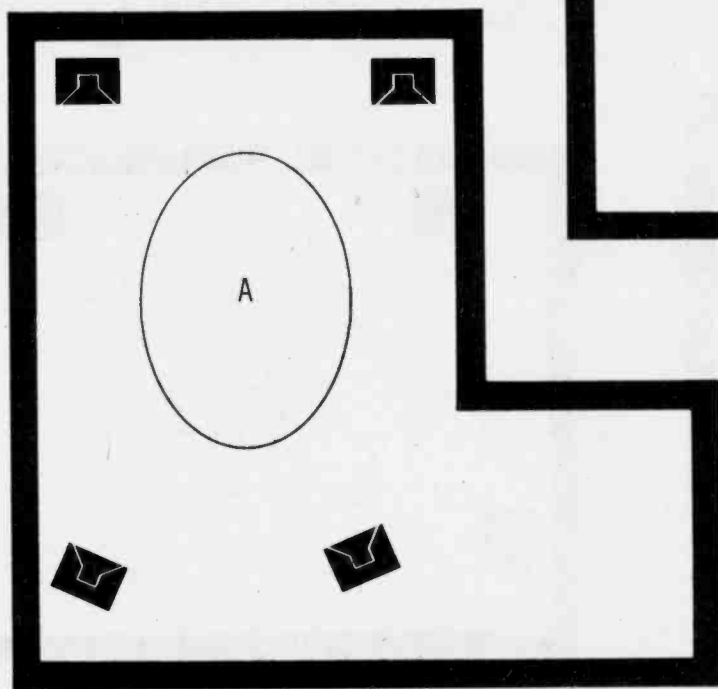


Fig. 14

and RB (right back). This placement also has been widely (though not exclusively) used at shows and demonstrations. It is not, however, the only arrangement possible. And in some instances it may not even be the most desirable, nor conducive to optimum results. We are in truth only on the threshold of four-channel sound, and much remains to be learned. The possible variables—in recording technique, speaker placement vis-à-vis room acoustics, and so on—seem more numerous for quadraphonic than for conventional (two-channel) stereo.

Nonetheless, even at this stage in the game, it seems apparent that a few ground rules can be sug-

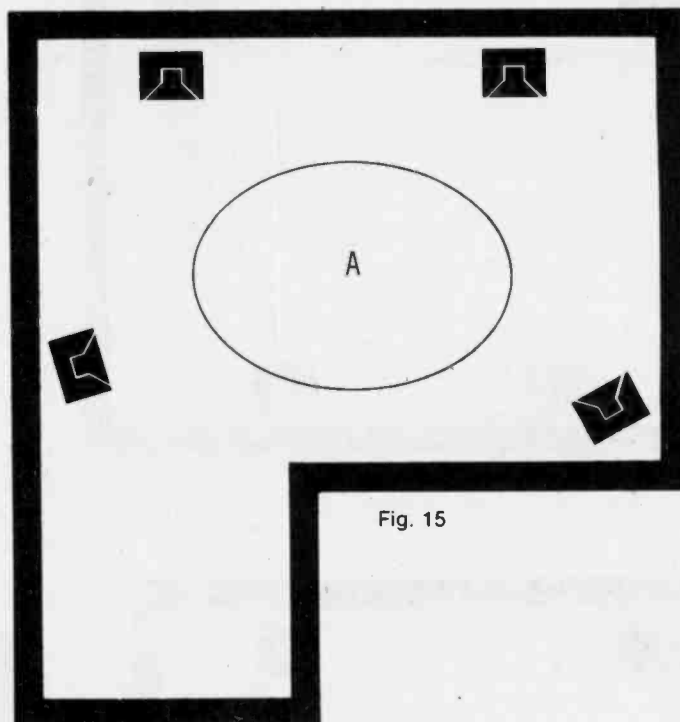


Fig. 15

L-shaped rooms present special problems. If original stereo (front) speakers are on short wall (Fig. 14), rear speakers may be added asymmetrically to produce good quadraphonic effect in area "A." More experimentation is called for with this type of room than with rooms that are rectangular in shape.

In L-shaped room in which main speakers are on long wall (Fig. 15), rear speakers may be added, probably asymmetrically. Note that in both diagrams one of the added (rear) speakers will get bass reinforcement due to proximity to corner. Other rear speaker will produce less bass. In both instances, adjustment of level and or tone controls may be required to get optimum balance for good quadraphonic effect.

gested. In general—and ideally—the speakers (in any sound system, mono, stereo, or quadraphonic) should be placed: 1), to take advantage of the acoustical characteristics of a particular room with respect to the speakers' own response and dispersion characteristics; while 2), at the same time affording a suitable presentation of the program material being reproduced (for stereo, that is, the speakers must be separated by about the same distance from the listening area); and 3), also fitting in with the room's general seating and décor plan. Let's call this the "A B C" of speaker placement: A for acoustics, B for balance, and C for comfort. It is a big order and is far easier to state than to achieve

in many homes. I know of no formula or simplified procedure that you can follow to accomplish this threefold ideal. In the vast majority of installations (my own included) the placement of speakers must be a compromise between these three criteria. Inevitably, one factor wins out over the others. From an acoustical standpoint (i.e., the reason you bought the equipment in the first place), the least desirable factor to allow to outweigh the others is the one dealing with room décor. More often than I care to recount, I have seen and heard stereo systems that were installed primarily from a "how it looks" standpoint rather than from a "how it sounds" standpoint.

For instance, I've seen expensive and very fine speaker systems that produced little clean, full bass: They were incorrectly baffled to get them to fit into an impossibly small space, or—if correctly housed—were placed in the wrong parts of the room. I've seen others that had perfectly good tweeters but were producing inadequate highs: They were radiating at, and being blocked by, an overstuffed chair. And so on.

Obviously these considerations become more demanding the more speakers you have. If you are seriously into stereo, you probably have worked out reasonably good locations for your two speaker systems. But now along comes quadraphonics with two more speakers that are, according to the prevailing trend, supposed to be placed at the opposite end of the room and symmetrically with respect to the original pair.

If you start with a bare room, you may have a fighting chance of accomplishing this arrangement. But if you are adding rear speakers to an existing stereo setup, or if you are putting an entirely new four-channel system into a room that already is furnished and being lived in, you could and probably will run into some hairy problems vis-à-vis that perfect rectangle pattern for locating the four speakers. I mean you might just not want to take down part of a book-and-storage wall to make room for two more speakers. Or you might not care to shift your favorite paintings or posters that happen to be lined up on the wall with respect to the "correct" speaker location. Or, you might have a sofa against this wall, which is a dandy spot from which to listen to stereo from the two speakers at the opposite end of the room, but which might not be so great for four-channel sound with the "rear" speakers at your elbows.

Some new four-channel installations I've learned about tackle the problem of locating the rear speakers by installing them relatively high up on a wall, even at the juncture of wall and ceiling. Fine, as long as the owner can manage that sort of décor gymnastics (either himself or by hiring someone to

do it), and as long as the speakers—once positioned up there—really sound good. I suppose getting two people up on ladders, holding the speakers in the approximate proposed locations, and playing some four-channel material may be the only practical way to judge whether this type of setup really will work—in your room.

What I'm getting at is not that four-channel setups are "impossible." On the contrary, they are very possible—but not necessarily in the formal rectangle pattern that has been so far almost universally proposed. In fact, once you get away from rigid adherence to that pattern you find that you can set up four speakers that produce the quadraphonic effect and also satisfy, at least to some degree the "A B C" requirements I mentioned above. Four-channel setups have emphasized the "B" aspect. Of course, you should try to get the speakers as well balanced in terms of relative distances as possible. But even with speakers placed markedly out of a rectangular pattern, surround sound is still possible—those balance and level controls on your amplifier or receiver are not only for the program material, but for relative differences between the speakers. If, for instance, you have to place the left-back speaker farther away from your listening spot than the right-back speaker, a judicious use of one or two control knobs often will compensate for the discrepancy.

There's another point that bears on this subject, and it has to do with the nature of the quadraphonic program you're playing. Unless the recording was made deliberately to put the listener inside a "circle of sound" (which implies equal or "primary" sounds coming at you from all directions), you can get very satisfying quadraphonic characteristics (a sense of living ambience, a greater "dimension" in the reproduced sound, offstage effects, and so on), without having to stick to that rigid rectangular arrangement for the four speakers.

What exact arrangement you should use depends of course on those other three criteria listed earlier. For instance, if your speakers seem a bit shy on the highs, you will not want to locate them too far below the level of your ears when you're in your favorite listening chair. Nor will you want to place them so that other things in the room block the tweeter. If your speakers sound a bit bass-shy, you will probably want to move them closer to two large adjacent surfaces (floor and corner wall, for instance) to reinforce the low frequencies. The accompanying diagrams suggest some of the general plans possible. Use them as guides, modifying them to suit your own needs and tastes and room situation. With a little experimentation and effort you probably will come up with a four-channel arrangement that works for you.

Pro
and
Con

Omnidirectional Speakers

ALTHOUGH "OMNIDIRECTIONALITY" has been espoused of late with considerable gusto, it is neither a new feature of loudspeakers nor the sole criterion of speaker performance. It is, however, an important feature—some contrary opinion notwithstanding.

The term omnidirectionality refers to a broadening of the sound waves produced by a speaker—and more precisely, of the treble portion, inasmuch as bass tones naturally radiate in a circular or 360-degree fashion. As frequency rises, however, wavelengths shorten and tend to form into a beam. The beaming tendency increases with the size of the speaker diaphragm, so that a relatively large-diameter speaker will "want to" beam high frequencies more readily than a smaller-diameter unit. This is one major reason for tweeters being traditionally smaller than woofers.

Which, of course, points up the obvious: that some effort to avoid beaming of the highs always has been a part of speaker design. Lately this one aspect has loomed quite prominently as a feature of speaker systems. Why?

To begin with, an overly directional speaker is a distorting speaker: midrange and highs that are concentrated in a beam sound unnaturally bright, edgy, harsh. Moreover, such sound reproduction, besides being unpleasant, tends to obscure the inner detail of musical textures and is especially degrading of complex instrumental passages. An upper string, for instance, playing in close harmony with a woodwind, might sound strong over a beaming speaker, but chances are you would not be able to recognize that you were indeed listening to the two distinct instruments playing together. Finally, such a speaker tends to sound like a hole in a box instead of a transparent "window" (or indeed an open window) on the performers; it imparts a constricted sense of eavesdropping instead of an unimpeded feeling of clear, open sound.

For years, designers of quality speakers have attacked this problem (along with others, such as

wide frequency range, low distortion, smooth and linear response, power-handling ability, and so on) in terms of tweeter designs that sought to achieve wide sound dispersion instead of narrow beaming. One of the strongest impetuses to this trend came from the movie sound people, at the time that they attempted to solve the sound-dispersion problem in theaters when the first talking pictures were shown some forty years ago. Moviegoers sitting in the extreme side seats of the theater couldn't hear the dialogue on the soundtrack nor distinguish sounds clearly because the upper-middle and treble tones (the frequency range that carries all the important overtone structures that define different sounds and voices) were not getting to them. The solution to that problem—the sectoral- or multicellular-horn type of tweeter—proved something of an engineering coup. Not only did it disperse the sound over a very wide angle, but it was inherently a device of great efficiency, since a horn loaded to a smaller driving element acts as an acoustic transformer by helping to match the high-pressure/high-impedance sound energy from the vibrating element in the horn's throat to the low-pressure/low-impedance energy at its mouth. This efficiency in turn meant that these horn systems could be driven to high output levels (big, room-filling sound) with the use of amplifiers that were themselves relatively modest in terms of size, power, and cost. The horn tweeter, in one style or another, has since found its way into many excellent home speaker systems.

Not to be outdone, advocates of cone tweeters have steadily improved their designs to achieve—although with the concomitant need for somewhat higher-powered amplifiers to properly drive them—pretty much the same acoustic results. An early design effort in this direction resulted in the whizzer—a small auxiliary cone or flat ring projecting near the apex of the speaker's main cone. Such a device can serve as an inexpensive way of extending, or at least of smoothing, the frequency response of a full-range speaker by decoupling the outer surface from

the throat so that the former handles only the bass. Its shape also helps to spread the high frequencies by diffraction: the effective treble aperture of the speaker becomes the diameter of the whizzer cone, while bass is produced over the remaining area of the diaphragm.

Many fine speaker systems use separate cone tweeters (which superficially resemble small woofers), and they achieve wide dispersion in several ways. They can use a really small diaphragm, two inches or less in diameter. Properly made, and backed by a hefty magnet structure, such a tweeter can produce excellent highs. In the last ten years the convex hemispherical dome tweeter has been used extensively. Because the sound tends to go out at right angles to the plane of the diaphragm, the outward-curved dome spreads the highs over a very wide angle. Some tweeters are found in many bookshelf speaker systems.

Using more than one tweeter to form a divergent array that covers a wide angle is another way to spread the highs. Yet another is the slot-loaded tweeter: the highs emerge from several tweeters radiating into a narrow slot that characteristically has a wide projection angle. Specially shaped cone units and plug-loaded midrange and treble cones have also been devised for fanning out the sound. Acoustic lenses—small slats or vanes that help spread the highs—have been used on both cone and horn tweeters.

All of these speaker types, which can achieve wide-angle dispersion of high, are based on fairly popular design approaches. One other that until recently received relatively little attention outside of engineering circles was investigated some years ago by Dr. Harry Olson, head of RCA Laboratories and a pioneer audio designer. He mounted the same loudspeaker in a series of enclosures, each of a different shape (though all having the necessary internal cubic volume to baffle the speaker correctly), and then tested each for dispersion characteristics. The best of those he tested was a design in which the usually flat mounting board (baffle) had been cut and reshaped to form an enclosure that approached a sphere.

This shape of course has appeared at times in the form of loudspeakers of the ball type and others in which the surfaces of the enclosure are used to mount an array of multiple drivers.

Many conventional speaker systems spread strong highs over 120 degrees; some do even better. A pair of stereo speakers, each having 120- to 150-degree dispersion, will spread the highs throughout any typical living room. If the speakers are set in the corners, 90 degrees of dispersion in each speaker will be enough to cover the entire room.

Only when a speaker system is placed mid-wall in a very wide room would 120-degree dispersion fail to cover most of the listening area.

Omnidirectional dispersion allows greater flexibility in speaker placement. For example, multidirectional systems need not—in most cases should not—be placed against a wall. Moving a conventional speaker out into the room would almost certainly produce dead spots in its coverage.

Though the wide-front dispersion commonly found in many of today's better speaker systems will produce a satisfactory stereo image, some speaker systems are aiming at even wider dispersion—up to 360 degrees, or omnidirectionality—at least in the horizontal plane. And a few are going after dispersion in more than just the horizontal plane by spreading part of the vertical plane in an umbrella effect. Indirect radiation, most prominently espoused by Bose, uses the room walls to reflect the sound. According to Bose about ninety per cent of the sound reaching the listener from the Model 901 has been reflected one or more times from the walls inasmuch as eight speakers face toward the wall in back of the speaker system and only one is in the front, pointed toward the listener. The one direct-firing speaker, triggering our hearing's precedence effect, is enough to establish a stereo image amid such a high preponderance of reflected sound.

Dispersion and Stereo How does dispersion relate to stereo? Actually, good stereo depends not only on a sense of left-to-right breadth, but also on the stability of that directionality. The localization of sound depends on our ears' ability to sense the relative strengths and timing of the sounds from the two speaker systems. Each of the two separate sounds that enter this comparison must seem to come directly from the relevant speaker. The mid-highs and highs are especially important. If the strength of the treble changes markedly as you move around the room, stereo localization will come loose from its moorings. Of course there always will be some change with motion in two-loudspeaker stereo. But if the highs are evenly spread, the stereo image should be at least reasonably firm—without jumps or reversals—throughout the listening area.

Furthermore, as long as some direct sound is still produced by a speaker, that direct sound will reach our ears a split second sooner than the indirect sound. For this reason omnidirectional speakers can indeed preserve the directional clues needed for stereo, some British commentators to the contrary.

But there's more. Wide-angle dispersion relates

closely to "broad-source" sound which seems to emanate from an area larger than the size of the speaker system itself. Inasmuch as good stereo coverage intrinsically presents an apparently broad source to the listener, the question of opening up or spreading out the sound from the individual speaker systems received less attention in stereo's first years than it did in mono days. But the concept of the broad source has invariably implied a more natural kind of sound: a sense of the proscenium, an ambience that suggests depth as well as breadth in order to achieve greater realism in music.

What does seem certain in the general omnidirectionality thrust is that stereo is being helped, not hindered. Since the direct highs from an omnidirectional speaker reach all parts of the listening area relatively unmuffled, the stereo image has maximum stability and it can be perceived from a greater number of listening spots in the room than is possible when using directional speakers.

This feeling, and one's evaluation of it, may be purely personal—but it has become a vital part of today's speaker designing. Indeed, when Quad and other companies first introduced these large, full-range electrostatic speakers the claim was that they gave the sensation of hearing the music as if it were coming through a large doorway. This broadening of the apparent sound source is also implicit in the Bose concept and other multiradiating systems—reproduced sound reaching the listener not only from the speaker directly but from the surrounding walls too by reflection.

Note, however, that a large radiating surface in itself does not guarantee wide-angle dispersion. Precisely the reverse would happen, for instance, in a large electrostatic panel for the same reason it happens in a large cone diaphragm; as wavelengths shorten with respect to the dimension of the surface producing them, they tend to form a narrow beam. Today's large electrostatics overcome this tendency in several possible ways. The Quad has a curved front which helps fan out its sound. The big flat electrostatics have frequency-sensitive sections which make sure that the extreme highs are reproduced only by a relatively small area. And an electrostatic—by being located at some distance from the wall behind it—can be made to function as a dipole or doublet so that a large portion of the rear radiation is reflected and mixed with the front radiation. This effect, of course, varies with the relative positioning of the speaker and so some experimentation is required for optimum results in a particular room.

The prediction and evaluation of reflected sound effects is, of course, a complex subject. A few British commentators have taken the position that sound

reflection equals sound interference, and thus these effects should be avoided at all cost by designing a loudspeaker to beam, thereby minimizing reverberation and concentrating sound energy in the directly propagated signal. American designers for the most part reject this concept.

In any event, it is obvious that poorly designed speaker units will not sound pleasing just because they put out highs in all directions. Thumping bass, honking mid-range, and screechy or edgy highs are not more acceptable when they come at you from all directions than when they hit you in a straight line. The over-all smoothness, transparency, and naturalness of a speaker system remain basic criteria. If a system has these virtues plus that of omnidirectionality—and it pleases you—then it is a speaker for you.

Dispersion and Four-Channel Sound To date, the accumulated insights—based on listening to available quadriphonic material played on a variety of systems and auditioned over various types of speaker systems—add little to what already has been stated, pro and con, on the subject of "omnidirectionality." It is true, of course, that the very adding of two more loudspeakers to a listening situation loads more sound into the room, and sets up new sound-radiation sources which in turn aid in the general dispersion of sound while simultaneously tending to further "wash out" deficiencies in room acoustics. And if the particular four-channel material itself contains deliberately recorded "ambient information," that ambience will be reproduced as part of the signal rather than induced as a condition of the listening room's acoustical character. And so, to that extent, the use of "omnis" for the rear channels would not appear to be as critically needed as for normal "up-front" two-channel stereo reproduction.

However, if the four-channel material is the kind that presents "primary signal" information on all four channels, then the desirability of maximum dispersion on all four channels becomes as important a factor as it might be for two-channel stereo. And, with any kind of material, the other advantages of ample dispersion still pertain. They would be, of course, an effective "enlarging" of the listening area, and a reduction in the system's phase distortion brought about by the "anti-beaming" effect of multi-angular dispersion of middles and highs. Finally, the question of balance on all four channels is paramount to optimum quadriphonic reproduction, and so if you have already installed speakers for stereo of a given dispersion pattern, ideally they should be duplicated for the added rear channels in a quadriphonic setup.

Adding Speakers for Special Effects

STEREO HAS PUT TWO speaker systems in our homes. Increasingly, it is also raising the question of why not more than two.

Already it's a fairly common practice to pipe music into various rooms of the house by means of ancillary loudspeakers connected to the stereo amplifier or receiver that drives the main (left and right channel) system. Additionally, proponents of a "center channel" are advising the serious listener to install in his regular listening room a third loudspeaker between the left and right sound sources, in an attempt to create the "wall of sound" illusion (or to fill "the hole in the middle"). Yet another group of enthusiasts urges the use of multiple pairs of loudspeakers in the same listening area to achieve reverberatory "surround" effects which approximate the acoustic ambience of a concert hall.

In short, ideas are burgeoning—but before you translate any of them into action, be sure you update your thinking in terms of the special aspects of solid-state amplifiers. In the past, references to

multiple speaker installation invariably included hookup diagrams showing the separate 4-, 8-, and 16-ohm speaker terminals found on amplifiers that used tubes and output transformers. Today's solid-state amplifier or receiver, on the other hand, typically has just one pair of speaker terminals per channel—unlabeled as to impedance, at that. Connecting an unlimited number of speakers in parallel across any amplifier's speaker terminals invites disaster. With solid-state units, excessive loading can destroy the output transistors (or, at best, cause speaker line fuses to blow or circuit breaker to chatter). Obviously, the subject of multispeaker hookups needs re-examination.

When considering speakers for secondary locations (e.g., den, kitchen, or bedroom), the question naturally arises: need they cost as much as those in the main listening room? They can, of course; but inasmuch as listening in these secondary areas will generally be a casual experience, more modestly priced speakers may serve the purpose. If, however,

the proposed arrangement includes the possibility of operating *only* the secondary pair of speakers (with the main stereo pair turned off), choose extension speakers whose power-handling capacity is large enough to absorb all the energy that your main stereo amplifier may feed them.

Extension Speakers— Some Music Wherever You Go

Consider too the efficiency of the secondary loudspeakers: how loud will they sound for a given amplifier's power output? Current loudspeakers on the market include efficiency ratings that vary from below 1% to higher than 10%—a variation to be found among expensive systems as well as lower-cost models. Ideally, the efficiency of the secondary system should be approximately equal to that of the primary system, thus obviating the need to rush to the main volume control to make readjustments every time the sound is switched from one system to the other.

Should you have acquired secondary speakers of widely differing efficiency from the main set, you can, however, adjust their sound level by means of L-pads wired to them. Such pads should be selected to match the impedance of the speaker each will control. The general method of interconnecting an L-pad is shown in Fig. 1; detailed instructions usually are provided by the manufacturer. Examples of such pads include the Switchcraft Part No. 651 (for 8-ohm speakers) and No. 651-S (for 16-ohm speakers). These are equipped with standard wall plates and can be mounted in standard outlet boxes, much as an electrical outlet or switch. Similar products are offered by Lafayette; and a new series of level controls employing autotransformer action has been introduced by Jensen in power ratings of 10 watts and a nominal impedance of 8 ohms. One of the models in this series is the LT-810 level control, which provides attenuation in 3-dB steps up to 27 dB, plus an "off" position.

The switching and wiring arrangement shown in Fig. 2 is both simple and effective. It permits you to connect two sets of speakers, and select either system A, system B, or systems A and B simultaneously. Except for the pad on system B, many recent amplifiers and receivers have such a facility as a built-in feature. If yours does not, you can make the hookup yourself, but first observe certain precautions.

1. Determine the lowest load impedance which may be placed across a channel of your amplifier or receiver without endangering the output transistors. For most units, this will be 4 ohms. If in doubt, check the instruction manual or query the manufacturer or dealer.

2. Determine the impedance of your primary speaker systems.

3. With this value in mind, select secondary speakers having an impedance which will permit you to employ the hookups of Figs. 2, 3, 4, or 5, depending upon your set of circumstances.

4. For the hookups in Figs. 2, 3, or 4, purchase an inexpensive three-position switch such as the Mallory 3223 J (double-pole, three-position rotary switch). For the hookup in Fig. 5, choose a switch like the Mallory 3243 J (four-pole, three-position rotary switch). Note that one of the four poles available would then not be used—I couldn't find a three-pole, three-position switch in the catalogues.

From one standpoint, solid-state amplifiers offer an advantage over tubed units in multiple speaker hookups. Generally, a solid-state amplifier will deliver its greatest power when connected to its lowest permissible load. For instance, an amplifier capable of delivering, say, 30 watts per channel into an 8-ohm load may be expected to deliver 40 or more watts when loaded with a 4-ohm impedance. Thus when additional speakers are connected across the output terminals, thereby reducing the *net* load presented to the amplifier (8 ohms in parallel with 8 ohms equals 4 ohms, etc.), more power will be available to drive the extra loudspeakers.

As mentioned above, this approach must not be carried to extremes, since there is a minimum load impedance below which operation of the output stages of the solid-state amplifier may fail, sometimes destroying the transistors themselves in the process. That is why Figs. 3 and 4 include series resistors. In Fig. 3, the combined impedance of an 8-ohm and 4-ohm loudspeaker would be approximately 2.7 ohms, were it not for the additional resistor inserted in series with the 4-ohm speaker when both systems are to operate simultaneously. In Fig. 4, the net impedance of two 8-ohm speakers in parallel would be 4 ohms, or half the safe 8-ohm value, were it not for the addition of the 8-ohm series resistors in the circuit when both speakers are to play.

Many purists will object to the insertion of series resistors as shown in Fig. 4, arguing that such modifications will lower the normally high damping factor associated with quality solid-state amplifiers. In other words, the speaker so encumbered will "look back" into a driving impedance of 4 or 8 ohms-plus, instead of into the fraction of an ohm internal impedance present at the speaker terminals of most quality solid-state amplifiers. Such an alteration of driving conditions very often reduces the transient response capabilities of the system (sharply percussive attacks become "muddied"). For this reason, Fig. 5 is presented as an alternative, even though it demands a somewhat more complex switching ar-

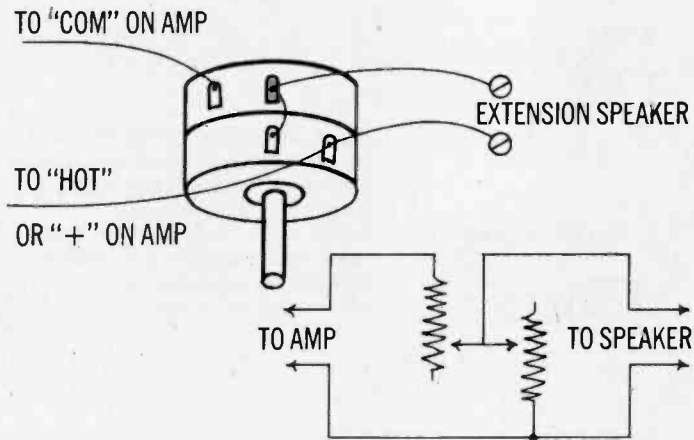


Fig. 1. Wiring diagram and equivalent schematic of an L-pad used as a level control for an added loud-speaker.

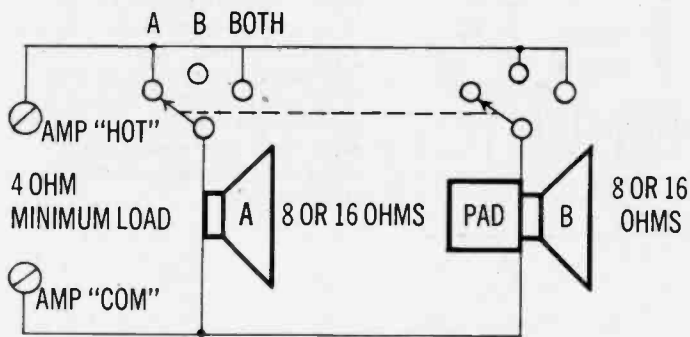


Fig. 2. Switching circuit for local (A) and remote (B) speakers, per channel, where both speakers are at least 8-ohms impedance, and amplifier can sustain a load as low as 4 ohms. Switch used is a two-pole, three-position type (see text).

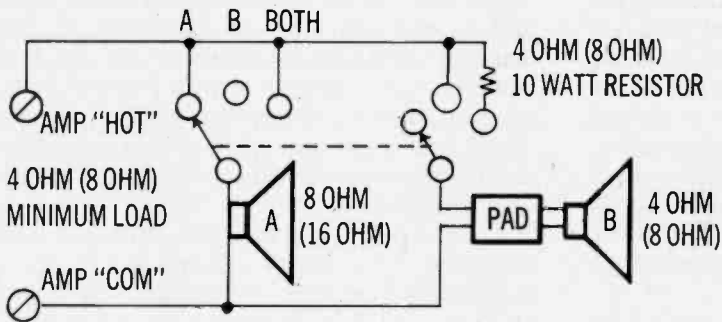


Fig. 3. Switching circuit for local (A) and remote (B) speakers, per channel, where primary speaker is of 8-ohms impedance, and secondary speaker is of 4 ohms. Amplifier requires 4-ohm load or greater. Read values in parentheses together for alternate situation in which this diagram applies.

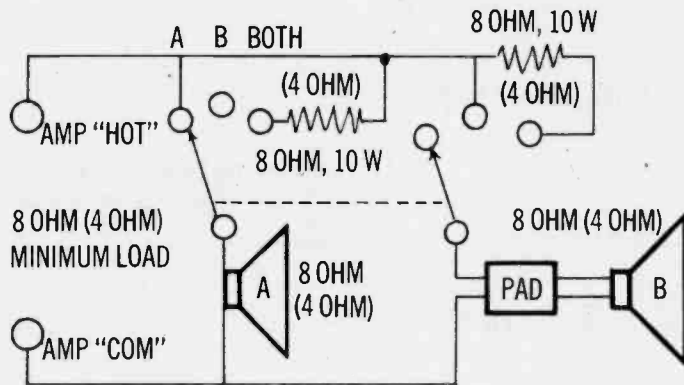


Fig. 4. Switching circuit for local (A) and remote (B) speakers, per channel, where each speaker impedance is lowest value permitted for the output of the amplifier being used. Read values in parentheses together for alternate setup in which diagram applies.

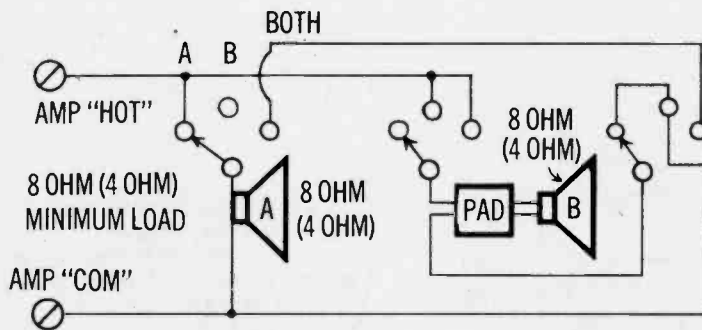


Fig. 5. This alternate setup to that shown in Fig. 4 eliminates the power resistors but requires a more elaborate switch. Note that in extreme clockwise position of switch, speakers are in series (rather than in parallel), thus presenting a doubled load impedance to the amplifier output.

rangement. Switchcraft's Model 670 Stereo Selector Switch is ideally suited to the hookups of Figs. 2, 3, and 4, containing two of the circuits shown (enough for *both* stereo channels of your system). If this product is to be used, however, make certain that the manufacturer of your amplifier permits "common" terminal connection of the return lead of speakers of left and right channels. Some amplifier circuits are not designed to permit such common connection, in which case *two* separate switches such as those shown in Figs. 2, 3, and 4 would have to be used—one for left channel selection, the other for right channel.

If you are currently planning a complete stereo system installation and do not yet own any loudspeakers, there is some "impedance planning" you can do at the outset if you plan to incorporate two or more pairs of systems. Suppose, for example, that you will ultimately want four pairs of loudspeakers, and that there may even be occasions

when all four systems will be in use at one time. Such a situation is not at all farfetched, for you might discover the benefits of "surround" speakers in your main listening area (a second pair of "enhancing" speakers mounted *behind* the listener, and attenuated somewhat with respect to the primary speakers by means of suitable L-pads). In addition, you might want a pair of inexpensive speakers in your den or recreation room and a fourth pair in a bedroom.

Based upon the connection principles already discussed, such a situation is best met by the use of 16-ohm loudspeakers, since connection in parallel of four such loudspeakers (per channel) would yield a net impedance of 4 ohms, a safe lower limit for most stereo amplifiers. In choosing such a high impedance for your speakers, however, bear in mind that your amplifier will produce its *least* maximum power when feeding only one pair. It is therefore important to choose an amplifier whose

power rating at 16 ohms is adequate in terms of your main listening area and your personal loudness preferences. To date, most manufacturers of amplifiers quote power ratings at 8 ohms or at 4 ohms. If queried, however, reputable dealers and manufacturers will translate these figures into 16-ohm power ratings.

Correct phasing of the added speakers is as important as it was for the original left- and right-channel systems. Where secondary pairs are used in other locations, the new pair need be phased only with respect to itself. Where a pair of "surround" speakers are used in the main listening area, they must be phased not only with respect to each other but with respect to the original left- and right-channel speakers as well.

Many loudspeakers are now marked for polarity (a plus sign, or a red dot, or the impedance rating number next to one of the terminals denotes connection to the "hot" or "high" terminal of the amplifier output). If your speakers are so coded, simply follow these indications for all parallel wiring. If no polarity is indicated on your speakers, determine phase by first connecting the new pair of speakers in an arbitrary fashion and listening to a monophonic program source intently. Note the presence or absence of sound seeming to emanate from between the new pair of speakers. If uncertain, reverse the connections to the terminals on *one* speaker only. Whichever connection yields the strongest bass response and the most defined "center" sound is the proper connection for in-phase operation of the new system.

Center Speakers— More Music Where You Are

The so-called center channel approach towards achieving an enhanced stereo effect has undergone alternating periods of popularity and disfavor. Derived from the basic two channels of stereo by a process of mixing, the center channel was originally advanced as a technique for overcoming exaggerated separation (the "hole in the middle"). The center channel was also found to enhance stereo solidity and to help create a wall of sound.

By center channel I do not mean the "mixed-bass" technique used by some manufacturers of stereo consoles or package sets. In this compromise approach, all low frequencies (whether from left- or right-channel program) are mixed together and fed to a single woofer or bass speaker, usually mounted in the center of the cabinet. Left and right speakers then consist merely of inexpensive midrange and/or high frequency loudspeakers which are not called upon to deliver any bass at all and can there-

fore be fairly small-sized units. Although proponents of mixed bass maintain that frequency separation is not essential at low frequencies, in controlled listening tests I and others have repeatedly disproved that premise.

In speaking of the center channel, I am assuming a basic system in which two normal wide-range speaker systems comprise the left and right channels. A center speaker is fed a judicious amount of left-and-right combined information merely in order to "fill in" and enhance the over-all stereo effect. Too little center channel contribution will remain unnoticed, while too much will detract from the needed separation effects inherent in stereo reproduction. Quantity of center channel audio needs to be carefully set by means of an L-pad.

In the days of vacuum tubes and more particularly of output transformers, it was relatively easy to create a third channel output from a stereo amplifier. A bit of rewiring of the 4-, 8-, and 16-ohm speaker terminals was all that was required. With today's solid-state amplifiers (equipped with only a "hot" and "common" terminal per channel), direct derivation of a third channel suitable for driving a speaker is not possible unless the manufacturer of the amplifier has made specific provision for this feature.

To create a mixed channel signal source with the newer amplifiers it may be necessary to use a third power amplifier in conjunction with the resistive mixing circuit shown in Fig. 6. Since the extra amplifier is only a mono power amplifier (no controls are necessary), many inexpensive (under \$100) solid-state amplifiers, including even public address types, or even a long discarded tube amplifier, will do very well for the purpose. Furthermore, since you will not be relying upon this amplifier for anything but a "fill in" function, its power-handling capacity need not be anywhere near that of your main stereo amplifier. Experiments have shown that in an average installation, with reasonable separation of left and right speakers, power fed to the center channel should be about 10 dB below that fed to the side channels. Ten dB represents a power difference of ten to one—which means that if your stereo amplifier is capable of delivering, say, 20 watts per channel, you will probably want to feed not much more than two watts of audio power from the extra center amplifier to the center speaker (assuming this third speaker has about the same efficiency as the other two). If this third amplifier has its own input level control, you can even dispense with the control shown in Fig. 6, since level setting—a one-time operation—can be accomplished by means of this auxiliary amplifier's own level control.

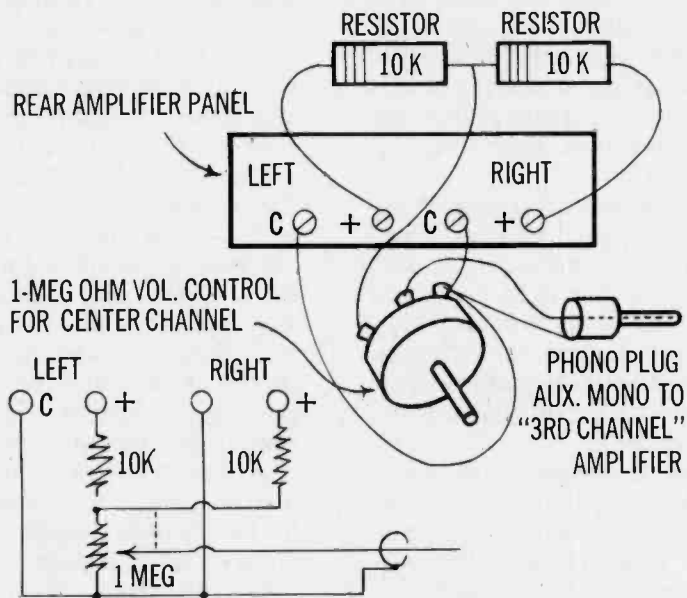


Fig. 6. Wiring diagram and equivalent schematic for mixing left and right signals to get a "center fill" to feed to an auxiliary amplifier and speaker. If auxiliary amplifier has volume control, eliminate the 1-megohm control and substitute a fixed 1-megohm resistor, wired in as shown by the dotted line on the schematic.

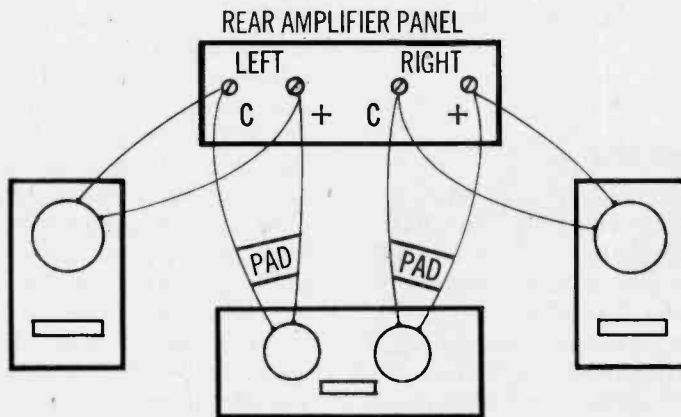


Fig. 7. Assuming your amplifier can handle the net load impedance presented by this arrangement, a center fill sound source can be set up by mounting two speakers in one enclosure and wiring them as shown. This hookup does not require a third amplifying channel but does call for L-pads wired to the center speakers.

If the thought of another piece of electronic equipment discourages your third channel aspirations, there is one other alternative, even with solid-state amplifiers. Try mounting two inexpensive six- or eight-inch loudspeakers in a single speaker enclosure. Parallel one of them to the right channel amplifier output and the other to the left channel amplifier output, using L- or T-pads as shown in Fig. 7. Since both of these additional loudspeakers are in such close proximity to each other and mounted in the same enclosure, an acoustic rather than an electronic mixing of left and right channels will take place and an effective "third channel" fill will result.

Level setting of third channel output is really the key to success of all third channel endeavors. Do not make the mistake of running the third channel at too high a level as this will tend to reduce the stereo illusion. Correct level set can be described as that level which maintains full stereo effect but also significantly improves the desired illusion of a total wall of sound.

As I have implied, there is no need to purchase a third channel speaker capable of bass response down to 50 or 40 Hz. It is presumed that your initial setup provides sufficient bass and loudness. The real criterion for a center channel speaker is that it be as distortion free as possible over its rather limited frequency range. Even this requirement may be modified, for the third speaker will be contributing only about 5 to 10% of the total sound in the room. Thus, even in the extreme case of a center speaker's having 20% distortion of its own, the *net* harmonic distortion contributed to the total sound will be only 1 or 2%.

With all this "paralleling" of loudspeakers—for any of the above applications—there is one more precaution that should be observed. We have been speaking of the impedance of loudspeakers as a hard and fast number of ohms. The truth is that the impedance of a loudspeaker is a rather nominal figure. Usually, a manufacturer of loudspeakers will state impedance at a single frequency, say 400 Hz. In many cases, the measured impedance will vary above and below the nominal value, often by a wide margin, at frequencies other than 400 Hz. As a rule, impedance runs higher at the very high frequencies, dips somewhat in the middle range, rises sharply at the resonant frequency of the speaker, and falls sharply at frequencies below resonance. Applied to older vacuum tube amplifiers, these excursions in impedance merely meant a reduction in optimum power transfer from amplifier to speaker. In solid-state amplifiers, the consequences may be more serious. If the impedance of a loudspeaker at a particular frequency dips sharply below its nominal value, it may be so low as to exceed the safe

lower limit of the amplifier and excessive output transistor current may flow, ultimately damaging the output circuitry of the amplifier. Normally, the dip in impedance of most loudspeakers is not so great as to cause damage. Assume, for example, that a loudspeaker's nominal impedance of 8 ohms actually drops to 5 ohms at a frequency just below resonance. Since most amplifiers can be safely operated with a 4-ohm load, no problem arises. Now, connect two such speakers in parallel. The combined *nominal* impedance will be 4 ohms—ordinarily safe. However, at the subresonant frequency where each loudspeaker exhibits an impedance of only 5 ohms, the combined parallel impedance will be 2.5 ohms—which may fall below the safe limit for many solid-state units. Fortunately, very little program material contains an excessive amount of subresonant frequency material; and when it does occur, it is usually short-lived. Still, the impedance characteristic of a loudspeaker (or of paralleled loudspeakers) should not be ignored altogether. Many manufacturers, aware of this potential hazard, have begun publishing *curves* of impedance rather than stating the impedance simply at a single frequency. Such a curve would look about like that shown in Fig. 8. More significantly, some manufacturers are tightening their specifications and designs to insure that the impedance of their loudspeakers never goes *below* the stated nominal impedance. This trend bodes well for the future health of our output transistors and their associated circuitry.

Your amplifier was designed to drive at least two pairs of loudspeakers and perhaps more. By taking advantage of its built-in capability (either by adding speakers in other locations or by enhancing the sound in your main listening area), you will be utilizing your equipment for all it's worth and increasing your own listening pleasure for a relatively small additional investment.

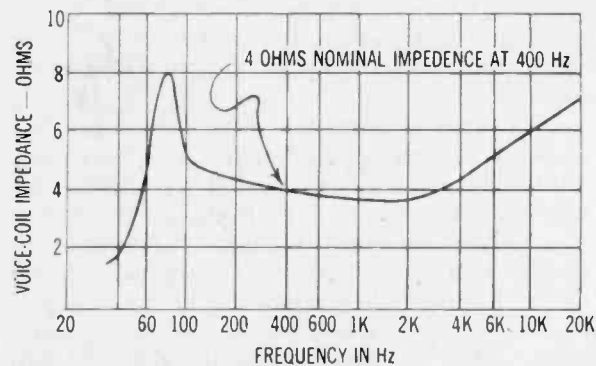


Fig. 8. Impedance curve of a loudspeaker taken over its full range shows how load varies with frequency.

Can electronic controls change your room's acoustical shape?

Speaker

A RECENT SOLUTION to the problems of room acoustics, by attempting to "custom-tailor" the output of a sound system to better suit the acoustical character of a particular room with reference to the sonic character of a particular speaker system, is offered by a new class of tone controls that are more elaborate and flexible than previous controls. The new type may range from a group of three controls on an amplifier or receiver (adding a midrange to the normal bass and treble controls) to a completely separate unit patched into a system and known as a room or speaker-equalizer. The basic idea is to use electronic compensation to correct for deficiencies in response that conventional controls cannot handle.

Because transducers (pickups, as well as loudspeakers) are known to be the least perfect elements in any sound system, there is ample justification for using electronic equalization or compensation to help smooth their response, or make it more linear—especially since electronic compensation can introduce enough variation to counteract the undesirable effects caused by the listening room, which has its own resonances, attenuation characteristics, and reverberation peculiarities.

Controls in one form or another also are justified on purely psychological grounds. Call it "electronic musicianship," but I believe that high fidelity enthusiasts enjoy having a multitude of controls at their command—much as sports car enthusiasts delight in having additional metering facilities and optional extras in their vehicles. In my view there is nothing wrong with tailoring one's sound to one's taste—and if this means creating orchestral balances never dreamed of by a composer, may I quickly add that J. S. Bach surely never dreamed

his two- or three-part inventions would be reproduced via a Moog Electronic Synthesizer either. (Actually how far away from electronic music are the many controls to which we have access these days?) Nor, for that matter, did Berlioz—in his wildest flights of fancy—ever envisage that his *Grande Messe des Morts* would be captured on a plastic disc (or ribbon) and released via two big boxes (or four) in a twenty-foot living room. The amount of electronic compensation involved in this process and the attendant number and variety of knobs, levers, and switches required constitute in sum an art/science form related more to the taste of the listener than the intent of the creator.

The Conventional Controls

In recent years, as more and more stereophonic reproducing equipment was manufactured, many controls, which were considered necessary at first, have all but vanished from the scene. One such was the phasing control found on the first stereo amplifiers. Today, phasing standards are so well established that once your speakers have been connected to work in phase they will continue to do so for all program sources, including the very complex stereo FM broadcasting techniques. Ergo, no more phasing control.

An early control that has not disappeared completely, but is seldom seen on current equipment, is the normal/reverse switch that enables you to interchange stereo channels, left becoming right and vice versa. Channel standardization, like phase standardization, has all but rendered the control superfluous. Still, many listeners like to have it. Aside from personal whimsey in perhaps flipping

Equalizers

performers back and forth across an imaginary stereo stage, the channel-reverse control can be handy in simple trouble-shooting, like isolating a defect to a particular channel.

Associated with the normal/reverse function was a series of mode positions that enabled you to hear through both speakers the left-only signal, right-only, or a mixture of left plus right. The last of these positions, actually a monophonic mixture, has remained as the mono setting of most mode switches. The other two settings have been dropped from most units in the interest of simplicity, though they did provide one measure of flexibility which is lost as a consequence.

Some of the first stereo amplifiers were equipped with independent left and right controls in addition to a master volume control. The theory here was that the user first set his master volume control to a suitable listening level and then, by means of the separate left and right controls, adjusted the total sound for correct stereo balance. Because most stereo users found this control system cumbersome and confusing, the separate level controls were replaced by a balance control, a single knob that adjusts left and right signal levels relative to one another. Certainly this control represents an improvement and a much needed simplification, but it does lack one possible advantage: matching signal levels to those assumed by the action of the unit's loudness compensation.

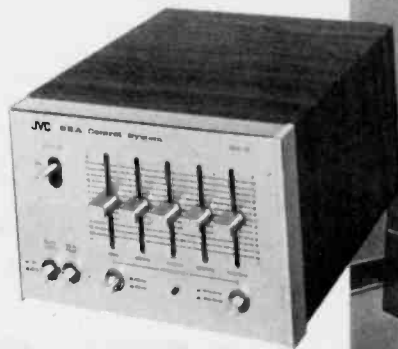
The loudness contour switches that are supposed to compensate for low listening levels by adding prescribed amounts of bass (and sometimes treble) emphasis at various settings of the volume control—more compensation for low settings, less for high settings—are now inflexibly tied to the internal amplification of the equipment. To use a loudness

compensation switch correctly, one must have access to separate input level controls for each signal source. In the absence of independent channel-level controls, this ability has been lost by all but a few pieces of equipment that still offer rear-panel input-level controls for external signal sources you may decide to connect with the system.

As noted earlier, the balance control seems destined to remain a feature of all stereophonic amplifiers. So does the master volume control (or dual-ganged variant that functions as both level and balance controls). If correctly designed, it is capable of reducing or raising the levels on both channels uniformly—that is, with little tracking error over a range of more than 60 dB. In practice, however, it is often necessary to use the balance control to compensate for the poor tracking of an inferior volume control.

Tone controls were staples of sound equipment through the monophonic era and are still with us. Despite the protestations of the sound purists, many experienced listeners agree that tone controls are needed to compensate for room acoustics, signal-source deficiencies, and listening tastes. By "tone controls" we mean separate knobs for bass and treble. At one time the array might also have included a presence control to boost a narrow range of mid-frequencies to give prominence to a soloist. Presence controls largely disappeared with the advent of stereo, since the stereo image itself now does the job of placing the soloist in a front-center position. But the midrange control is making a comeback as I shall explain further on in this article.

Basically, stereo tone controls come in three possible forms. The simplest are made of dual-ganged potentiometers that accentuate or attenuate both left and right channels simultaneously. A more ver-

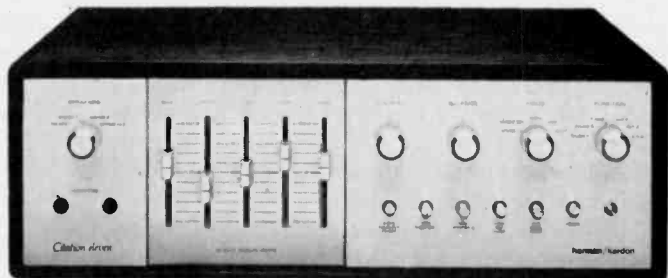


Multi-band tone controls form the basis of the Sound Effect Amplifier (SEA) control system vigorously promoted by JVC. Individual SEA units are available as well as amplifiers and receivers that include the SEA feature. In addition to providing more flexible control over tonal ranges, this approach can compensate for variations in recordings, response characteristics of a system, room acoustics. In the SEA system the basic "center frequencies" are 40 Hz, 250 Hz, 1 kHz, 5 kHz, and 15 kHz. A recent use by JVC of the SEA system is its "Audio Doctor" clinics at hi-fi dealers. Listeners are advised as to their hearing sensitivities, and offered hints on balancing tone controls in a given room.



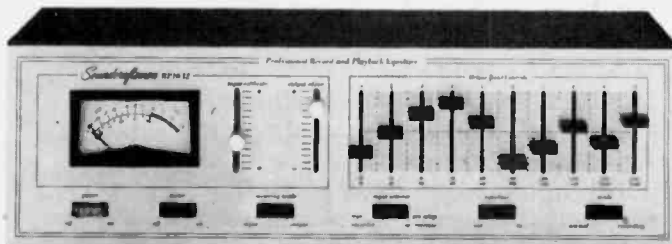
BSR, known chiefly for its turntables, recently announced a line of frequency equalizers for use in both recording and playback. The model FEW-3 shown here is a stereo unit with twenty-four sliders to cover twelve octaves on each channel. Dual VU meter is included. A more modest unit is the BSR FEW-2 which operates in five frequency ranges with separate controls for each stereo channel. BSR also has announced a four-channel (quadriphonic) version, the model FEW-4 which is essentially a doubled-up FEW-2, offering ten controls for front and ten controls for rear controls.

Trend to multi-band tone controls is reflected in the use of five sliders on the Harman-Kardon Citation Eleven preamp. Nominal center frequencies are 60 Hz, 320 Hz, 1 kHz, 5 kHz, and 12 kHz. These controls operate on both stereo channels simultaneously.

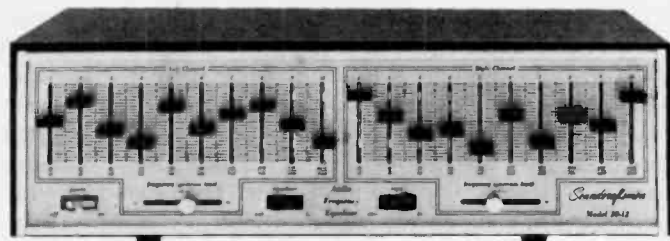




Recent electronic units (preamps, integrated amps, and receivers) from Marantz feature multi-band control systems, with three ranges per stereo channel. In addition to separate sliders for lows, middles, and highs, Marantz system provides selectable frequency turnover points for added versatility.



Very elaborate and versatile frequency equalizers are offered by Soundcraftsmen. Model RP 10-12 (above) is professional grade single-channel unit for use in recording and in playback. Ten slider controls are used; device has VU meter and various options for installing and using. Model 20-12 (right) is stereo unit more geared to playback. It provides ten sliders on each stereo channel; comes with test record.



Altec's Acousta-Voicette stereo equalizer utilizes twenty-four adjustments per channel to "tune" the response of a system, including the listening room itself. The work is done by a trained technician, and the unit is left installed in the system. For a detailed account of how it worked in one system, see the accompanying report.

satile and complex tone control is the kind that involves the use of ganged but mechanically independent controls so that the pair may be operated as one—often through a friction-clutch arrangement—or as two independent knobs. The most elaborate bass and treble tone-control arrangement—found as a rule on the costliest units—offers four totally independent tone controls, i.e., separate bass and treble controls for each channel.

Some equipment offers a switch that bypasses the tone controls completely. This addition is not as ludicrous as it might first appear, for there are times when you might want to return to absolutely “flat” or uniform response, and the flat settings on conventional tone controls often fail to correspond to electrically flat response. In addition, some forms of tone-control circuits introduce phase shifts at certain frequencies which, in theory at least, can partly degrade stereo separation or cause slight distortion. An alternate to the tone-control-cancel switch is the type of tone control circuitry that drops out of the amplifier circuit when the associated knob is turned to the flat position. Yet another refinement is the stepped tone control, which makes contact with individual resistors and/or capacitors to achieve precise and repeatable settings.

Although not all tape recorders are equipped with a separate monitoring or playback head, nearly all of today’s amplifiers and receivers include a tape monitor switch, ostensibly intended for just this type of tape machine. This control (usually in the form of a two-position switch) is nothing more than an interruption in the amplifying circuit to enable the insertion of a tape-monitoring signal. Actually, this circuit-interrupt feature can be put to other uses, such as the insertion of some of the newer pieces of equalizing equipment, which typify the latest thrust in controls for stereo.

The Unconventional Controls

A relatively new form of tone control is the “spectrum contouring” control. Tailoring the over-all response curve to suit specific requirements is of course old hat in both the recording and broadcast fields. Precision equalizers capable of shaping a frequency response incrementally, as well as expanders and compressors (or limiters) which increase or decrease dynamic range, are widely used by professionals. Until now, however, very few home audio products sported such sophisticated controls.

In one sense, the appearance of these new controls constitutes a measure of honesty about product performance not found in any other industry.

The manufacturers of these devices are admitting, in effect, that the loudspeaker is not perfect; that your listening room is not a concert hall; and that your otherwise excellent stereo pickup cartridge may indeed have a peak at around 12,000 Hz (something you suspected all along). They’re hinting too that FM broadcasters cannot transmit the full dynamic range of every musical selection and still observe the rules and regulations that cover the broadcast field.

The most predominant new control seems to be an elaborate replacement for the familiar bass and treble controls of your present stereo system. At least a half dozen products in this category are already on the market and more seem to be on the way. Basically, the principle involves boosting or attenuating restricted bands of frequencies, often by carefully calibrated amounts. By way of illustration, JVC—which has prominently espoused this form of control in its SEA (Sound Effect Amplifier) design—explains that the range of an ordinary tone-control combination is limited to boosting or attenuating the entire range of highs and/or lows in a prescribed, and not necessarily ideal, relationship. Thus, if your cartridge has a peak around 12,000 Hz, turning the treble control counterclockwise, by even a small amount, will not just reduce that peak but will affect the frequency response all the way down to 1,000 Hz or even lower. Similarly, a loudspeaker which has a significant “hole” at around 200 Hz (but is otherwise low in distortion at that frequency) cannot be compensated for by the mere clockwise rotation of the bass control. Frequencies all the way up to at least 500 Hz will be boosted to some degree, altering the desired tonal balance of the most important mid-frequencies. By providing individual adjustment of seven frequency ranges, this system comes up with vastly increased tonal compensation capabilities.

Interestingly, measurements of various listening rooms have proven that the rooms themselves may often exhibit narrow-band peaks, particularly at lower frequencies where the room behaves like a resonant chamber at a frequency of, say, 150 Hz. A conventional bass tone control rotated counterclockwise would produce only partial correction, but the use of just one compensating segment of the SEA system (or any other similar system) could offer more precise correction.

How many frequency segments are needed seems to have become a new source of controversy. Harman-Kardon in its Citation Eleven preamplifier features five sliding controls capable of ± 13 dB of variation at center frequencies of 60, 320, 1,000, 5,000, and 12,000 Hz.

An elaborately divided spectrum shaper is the

Acousta-Voicette Model 729A, introduced by Altec Lansing, as an outgrowth of its Acousta-Voicing technique developed some years ago to help improve the performance of sound-reproducing or sound-reinforcing equipment in large rooms and halls. After measuring such annoyances as standing waves, sonic holes, and resonances, the engineer would insert compensating networks or filters in the amplifiers to be used. The results have been described as productive of smooth, natural sound in places that hitherto were notoriously poor for sound. The present Acousta-Voicette is essentially a simplified and less costly way of accomplishing similar results in home music systems. It divides the total audio spectrum into twenty-four adjustable segments of one-third octaves (on each channel) and offers up to 12 dB of attenuation on each segment. The main targets of Altec Lansing's device are room acoustics and speaker response peaks; by correcting these factors the company feels it is achieving true "environmental equalizing." A detailed report on the "Acousta-Voicette" accompanies this article.

Those audio designers who are opposed to such elaborate tonal compensation devices argue that the average home user is totally unequipped to do a real equalizing job on his living room and/or sound system inasmuch as he lacks the requisite sound-level meters and other sophisticated test equipment used by professionals. In experimenting with two of these new devices, I can state that the combinations of sonic effects made possible by arbitrary or random placement of all the tempting sliding levers is endless and that when used without discretion, the audible results can be most unmusical and in fact devastating. Still, is this any reason to discourage experimentation? I think not. I believe that we may be witnessing the emergence of two different but parallel goals.

On the one hand we have the conservatives, whose quest remains the reproduction in the home of sound that most nearly approximates the live concert hall listening experience. Their radical counterparts, on the other hand, contend that concert hall simulation is irrelevant to the home listening experience, particularly in light of new recording/production techniques that make little or no attempt to duplicate the concert hall experience. From this standpoint it can be argued that controls may be used creatively, somewhat akin to electronic music, and that the more flexible the control setup, the more creative the listener can become. These listeners tend to feel as involved in the creative process as were the composer, conductor, and musicians.

And yet both groups may well accept the new

controls. The conservative will use them to make minute and subtle refinements in his stereo system (listening room included), while the radicals can experiment to their hearts' content—and if they upset the levers so badly that the music seems to be coming over a telephone receiver placed inside a beer barrel, aren't they entitled to do so?

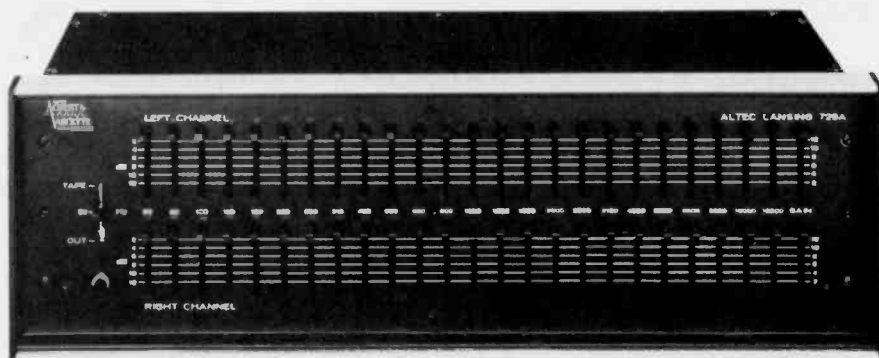
The "active" (i.e., amplified) equalizer associated with a speaker system such as the Bose represents yet another approach to tonal equalization in that the equalizer is designed to overcome deviations from acoustically flat response by the speaker systems as well as from varying types of input sources, including recordings and pickups. The active equalizer offers a total of twenty combinations of response and so it too provides increased equalization positions compared to the conventional tone-control arrangement.

Yet another type of speaker control, which is not an equalizer in the usual sense and can be used with frequency contouring or not, is the dimension device just brought out by David Beatty, a prominent Kansas City, Missouri audio dealer and installer. This unit permits installing two stereo pairs of speakers in one room and then varying the apparent stereo spread among them from a relatively narrow aural focus to a greater sense of breadth.

Danger Signs—and Hope

At best, the new controls can add an audible improvement to most stereo systems by overcoming problems of room acoustics, speaker system imbalance, or deficiencies in program material. Conceivably they can, with judicious use, virtually change the acoustic shape of the listening room—or at least improve the performance of speakers in that room.

Obviously, the apparent duplication of control functions will require a new kind of orientation on the part of stereo listeners. Just as obviously it's going to take some practice and restraint to use the new controls effectively. If the spectrum equalizers are intended to replace conventional tone controls, then those tone controls should be left in the flat position. Just because some spectrum contouring devices afford ranges of ± 12 dB or more on each of their many levers is no reason to suppose that a pattern of hills and valleys should be set on the levers when one is trying to equalize one's surroundings or speakers. Usually, moderate amounts of compensation at specific audio ranges will do the job beautifully unless, of course, you just want to have some fun and create your own kind of music—one totally unrelated to the real thing.



“Tuning” a Room with Acousta-Voicette

ALTEC LANSING's claim for its “Acousta-Voicette” process that it is “the most significant breakthrough in the improvement of home high fidelity sound since stereo” seemed to us, at first blush, not only immoderate but highly unlikely. Now after using the system in a 20- by 27-foot living room for the last five weeks its owner finds himself essentially in agreement with that claim. And even those who may balk at the strong phrase “most significant breakthrough” will have to admit that a vast improvement—in an already top-quality system—has been accomplished by the “voicing” process.

The unit itself is a direct offspring of the much more expensive and sophisticated commercial “Acousta-Voicing” system developed in 1967 by Altec Lansing to cure the often massive acoustical problems of such environments as churches, auditoriums, music centers, and recording studios. The theories involved are not difficult to understand. Since a listening area may offer anything but flat response for all the reproduced frequencies of the musical spectrum, Altec has designed a device that compensates both for the unique problems of an individual room and for the particular manner in which loudspeakers perform in that room. Furniture, drapes, windows, pictures, books, bookshelves, and the walls themselves—to name but a few possibilities—all to some degree collect, absorb, and reflect sound. The end result is erratic response caused by standing waves, holes, peaks, and valleys in the frequency spectrum. These effects not only can degrade the sound of the best reproducing equipment, but they can cause a speaker system to sound different—and often in an unpredictable way—from one room to another or even from one location to another in the same room. These effects also can mask a portion of the music, especially the inner details of heavily textured passages.

The Acousta-Voicette is a two-channel active-filter critical-band equalizer with a frequency response from 20 Hz to 20 kHz (± 1 dB) at less than 0.5 total harmonic distortion. The equalization center frequencies are from 63 Hz to 12.5 kHz at

$\frac{1}{3}$ -octave centers.

There are forty-eight active filters (twenty-four per channel). Each is designed for a maximum cut of 14 dB. Their “skirts” (the sloping sides of their responses) cross each other at a 7-dB level down, which permits the total filter action to provide a continuous shaping effect for a smooth over-all frequency contour characteristic. To recover any signal loss due to the filtering, the 729A also provides some circuit gain. The device, by the way, will work satisfactorily if it is simply patched in between a separate preamp-control unit and a basic amplifier, but the preferred “location” is ahead of a stereo system's master gain or volume control which—in most home equipment—translates to the tape-monitor facility commonly found on receivers or amplifiers. The reason for this is to avoid any possible increase in the system's noise level.

Front-panel controls include the forty-eight sliding tuners for all the filters (twenty-four per channel), plus a gain control for each channel, and a three-position “tape/in/out” switch that serves to reinstate the tape-monitor function if it has been pre-empted by the hookup, and also permits an A/B comparison of how the system sounds with and without Acousta-Voicing. When equalizing has been completed, and you are satisfied with the results, a glass cover may be screwed over the front panel to prevent accidental rearrangement of the critically adjusted slide controls. The rear of the unit contains stereo pairs of signal jacks for tape input, tape output, regular input, and regular output—in addition to the line cord and fuse holder.

While in theory you can tune your listening room without professional help, Altec doesn't recommend it and neither do we. We asked the Altec technicians to tune our room in two ways: first, by using the Altec-supplied test record (which contains material of one minute's duration for each of the $\frac{1}{3}$ -octave bands as well as wide bands of pink and white noise) plus a \$700 Hewlett-Packard sound-level meter, with built-in calibrated microphone; next, by using a signal generator in con-

junction with a real-time spectrum analyzer. Because of the high cost of the analyzer (a \$9,000 Hewlett-Packard unit that graphically displays the full audio spectrum in $\frac{1}{3}$ octaves) most dealers probably will use the meter method, which is a good deal slower and, unless very carefully utilized, perhaps a bit less accurate than the analyzer technique. The latter unit possesses the excellent facility of showing instantly the effect on adjacent bands when a single band is in the process of adjustment. According to A-L, a lower-cost version of the real-time analyzer is being designed now; it is expected to cost under \$3,000 and may find fairly wide acceptance among many audio dealer-installers.

Whether a real-time analyzer or a sound-level meter is used, if the test record (rather than the signal generator) is run as the source of signals you should ask the technician to first check the actual frequency response of the playback cartridge, noting its output before the signal enters the Acousta-Voicette. If any serious peaks or dips are discovered (4 or more dB departure from flat response), best results for Acousta-Voicing—and indeed for playback generally—will require replacing the pickup with one that has a demonstrably smoother response. Otherwise, the Acousta-Voicing will of necessity have to compensate for significant peaks (or dips) in the cartridge, and the resultant system compensation may prove to be well off linear response for other program sources, such as a tape deck or FM tuner, you may play through the system. For that matter, and for the same reason, the signal generator must be in top working order and should be calibrated.

Incidentally, there is no standard cost for installing a Model 729A when tuning a room; dealers have been charging up to \$75. The reason for this charge becomes apparent when you consider what is involved if the job is done conscientiously.

The first step is to plot right- and left-channel curves as they exist in the listening room. The "house curve" resulting from this initial plotting gives the necessary clues to where the individual filter adjustments will begin. The technician, starting with the left channel, locates the highest peak in the frequency response. He then plays that band back on the system while adjusting the filter for that frequency and watching the results on the sound meter (or real-time analyzer). The first attempts will smooth only the highest room peaks (no more than three and probably fewer than that). At this point an entirely new complete frequency response curve should be run in order to see the over-all effect of the initial adjustments. This pattern of gradually setting the filters and running and rerunning the frequency-curves is followed until the desired uni-

formity of response (generally within plus or minus 2 dB across the musical spectrum) is reached. The process is one of painstaking touching-up, of trimming and retrimming, with an eye on the instruments and an ear cocked for any audible signs of "protest" from the loudspeakers (the better they are, the more successful the room-tuning can be). There is, in short, a good deal of craftsmanship—call it art—involved in the work. The use of the real-time analyzer simplifies and speeds the work, but still demands a high level of skill and care on the part of the technician.

Because Acousta-Voicing represents a considerable investment the question comes up: "Is it worth the \$800 plus labor?" That question, it seems, is rather like asking if it is worth paying for first-class accommodations on a twelve-hour flight. Once you've tried it, if you can afford it, you wouldn't go any other way. Similarly, if you have first-class listening equipment, once your room has been tuned, the improvement in sound is absolutely dramatic; you can feel that your original setup is almost poor when you switch the Acousta-Voicette out of the system. A good deal of this effect, of course, depends on how poor the room was to begin with—but even in a good room, Acousta-Voicing makes a difference. With it, for instance, the second movement of Leinsdorf's Mozart *Jupiter* Symphony displays a delineation of individual instrument timbres in a way all too uncommon even in the concert hall; Bach organ fugues have a new clarity which, in at least one case, resulted in hearing a line of counterpoint previously well hidden; the vocal quintet toward the end of the first act of DGG's *Tannhäuser* took on the special impact of each of the minstrels speaking separately, yet together, as never before. The balalaikas of the Red Army Band surrounded their splendid choristers just as we remember them doing in Royal Albert Hall. The Mormon Tabernacle Choir sounded as big as it should and yet the Budapest Quartet sounded as small as it should.

Obviously, then, the total listening experience is affected. The key criteria are clarity, balance, true stereo effect (think how much poor stereo effect you've heard), warmth, and—most of all—a feeling of unblemished reality. There's another important factor: with the listening room itself correctly tuned—i.e., its deleterious acoustic effects eliminated from the playback—the true acoustic quality of the program material can emerge and be more clearly perceived. In this regard too, then, Acousta-Voicing enhances the realism of high fidelity reproduction.

The Altec 729A "Acousta-Voicette" measures 18 $\frac{3}{8}$ by 5 $\frac{11}{16}$ by 7 inches. Price is \$875. For additional information, write to the manufacturer.

Speaker Systems

To collect the data and information given in the following directory, High Fidelity sent uniform questionnaires to manufacturers. The absence of a particular item of information means that it was not specified or not yet determined by presstime. Speaker systems are listed by brand name (usually the manufacturer) alphabetically. A list of manufacturers' addresses is included elsewhere in this volume.

Information on each model is presented in the following order:

Generic class or loading principle (e.g., acoustic suspension, bass reflex, etc.).

Drivers: dimensions (in inches) of woofer, midrange (if used), tweeter.

Crossover frequency (or frequencies): This information, when applicable, is indicated by the letters CF. Included is the type of crossover and the frequency in Hz. Unless otherwise stated, crossovers are networks that divide the frequency range. A "mechanical" crossover refers to a special treatment of a speaker diaphragm to enable portions of it to respond more optimally to different portions of the frequency range. Both these types often are called "passive" in that they add nothing to the original signal. An "electronic" or "active" crossover is one that uses some form of gain (usually via transistors) and is most often associated with bi-amplification systems in which separate amplifiers drive woofer and tweeter.

Controls: (if none are included, this term is omitted in the description).

Rated impedance (Z) in ohms.

Power: minimum recommended driving power, and maximum power-handling capability. Power is stated in average sine-wave watts, also called continuous power, or "RMS" power, unless otherwise stated.

Rated response: The questionnaire requested lowest and highest frequencies (in Hz) followed by total dB variation, and with reference to an output level. Speaker output levels are cus-

tomarily specified as a value of dB/SPL taken at a short distance (usually 1 meter) from the speaker. The absence of this legend from any product listing indicates the data supplied was, to that extent, incomplete.

Following the above data, the listing includes—as applicable—any relevant remarks.

Dimensions (in inches) are given in order of height, width, and depth.

Weight (in pounds) is given.

Retail prices are those reported at presstime. Variations, including discounts on some models and/or in some locales, may be expected.

For detailed explanations of important areas of speaker performance, refer to the various feature articles in this volume.

ACOUSTECH

SB-1 Schiltz Beer Barrel

Air suspension. 8" coaxial two-way. CF: mechanical, 4,000 Hz. Controls: volume. Rated Z: 8. Power: min., 5; max., 30. Response: 50-18,000 Hz \pm 5 dB. 19½" diameter x 6" deep. 8 lbs. \$49.95.

SB-2 "Under Full Sail"

Same as Model SB-1 except 18H x 25W x 8D. 10½ lbs. \$59.95.

SB-3 "Ein Proslit"

Same as model SB-1 except 18H x 25W x 8D. 10½ lbs. \$59.95.

SB-4 "The Vineyard"

Same as Model SB-1 except 16H x 16½W x 7D. 6½ lbs. \$39.95.

ACOUSTIC FIBER SOUND SYSTEMS

KC35 "Kriket"

3½" driver. Rated Z: 8. Power: max., 5. Response: 150-10,000 Hz. Patented enclosure made of laminated acoustic fiberboard. 4½H x 5¼W x 4¼D. 1½ lbs. \$14.95.

ACOUSTIC RESEARCH

AR-LST

Acoustic suspension. 12" woofer, four 1½" midrange hemispherical domes, four ¾" high-frequency hemispherical domes. CF: 525 Hz and 5,000 Hz. Controls: six-position spectral energy profile switch. Rated Z: 4-16, depending on switch position. Power: min., 25; max., upon request to manufacturer. Response: 40-20,000 Hz \pm 1 dB. 20H x 27½W x 9¾D. 90 lbs. \$600.

AR-2ax

Acoustic suspension. 10" woofer, 3½" midrange cone, ¾" high frequency hemispherical dome. CF: 1,400 Hz and 5,000 Hz. Controls: midrange and high frequency continuous level. Rated Z: 8. Power: min., 25; max., 100. Response: 45-20,000 Hz \pm 3 dB, ref. 86 dB/SPL. 13½H x 24W x 11½D. 36½ lbs. \$165.

AR-3a

Acoustic suspension. 12" woofer, 1½" midrange hemispherical dome, ¾" high frequency hemispherical dome. CF: 575 Hz and 5,000 Hz. Controls: midrange and high frequency continuous level. Rated Z: 4. Power: min., 25; max., 100. Response: 38-20,000 Hz \pm 2½ dB, ref. 86 dB/SPL. 14H x 25W x 11¾D. 53 lbs. \$295.

AR-5

Acoustic suspension. 10" woofer, 1½" midrange hemispherical dome, ¾" high frequency hemispherical dome. CF: 650 Hz and 5,000 Hz. Controls: midrange and high frequency continuous level. Rated Z: 8. Power: min., 25; max., 100. Response: 45-20,000 Hz \pm 2½ dB. 13½H x 24W x 11½D. 39 lbs. \$215.

AR-6

Acoustic suspension. 8" woofer, 1¼" high frequency cone. CF: 1,800 Hz. Controls: high frequency continuous level. Rated Z: 8. Power: min., 25; max., 100. Response: 50-20,000 Hz \pm 2 dB, ref. 86 dB/SPL. 12H x 19½W x 7D. 20 lbs. \$99.

AR-7

Acoustic suspension. 8" woofer, 1¼" high frequency cone. CF: 2,000 Hz. Controls: two-position high frequency level switch. Rated Z:

Directory

8. Power: min., 25; max., 100. Response: 60-20,000 Hz \pm 2 dB, ref. 86 dB/SPL. 9 $\frac{3}{4}$ "H x 15 $\frac{3}{4}$ "W x 6 $\frac{1}{4}$ "D. 11 lbs.\$75.

ACOUSTIC RESEARCH ADVANCED DEVELOPMENT DIVISION

AR-MST/1

Acoustic suspension. 8" woofer, three 1 $\frac{1}{2}$ " cone/dome midrange/highrange drivers. CF: 1,600 Hz and 5,000 Hz. Controls: midrange and highrange switch. Rated Z: 8. Power: min., 25; max., 150. Response: 50-22,000 Hz \pm 2 dB. 14 3/16H x 21W x 7 $\frac{3}{4}$ "D. 25 lbs.\$159.

AR-10 π

Acoustic suspension. 12" woofer, 1 $\frac{1}{2}$ " hemispherical dome midrange, $\frac{3}{4}$ " hemispherical

dome highrange. CF: 525 Hz and 5,000 Hz. Controls: woofer environmental switch, midrange level switch, highrange level switch. Rated Z: 4-16, depending on position of woofer environmental control. Power: min., 25; max., 150. Response: 35-22,000 Hz +1 dB, -2 dB, ref. 86 dB/SPL. Woofer Environmental Control designed to adjust response to suit placement in room. 13 15/16H x 25W x 10 $\frac{3}{4}$ "D. 55 lbs.\$395.

AR-11

Acoustic suspension. 12" woofer, 1 $\frac{1}{2}$ " hemispherical dome midrange, $\frac{3}{4}$ " hemispherical dome highrange. CF: 525 Hz and 5,000 Hz. Controls: midrange level switch, highrange level switch. Rated Z: 4. Power: min., 25; max., 150. Response: 35-22,000 Hz +1 dB, -2 dB, ref. 86 dB/SPL. 13 15/16H x 25W x 10 $\frac{3}{4}$ "D. 49 $\frac{3}{4}$ " lbs.\$295.

ADVENT

Advent Loudspeaker

Acoustic suspension. 10" woofer, 1 $\frac{3}{8}$ " tweeter. CF: 1,000 Hz. Controls: 3-position switch. Rated Z: 8. Power: min., 20. Also available in vinyl-clad walnut finish cabinet at \$114. 25 $\frac{3}{8}$ "H x 14 $\frac{1}{4}$ "W x 11 $\frac{1}{2}$ "D. 25 lbs.\$132.

Smaller Advent Loudspeaker

Acoustic suspension. 9 $\frac{1}{2}$ " woofer, 1 $\frac{3}{8}$ " tweeter. CF: 1,400 Hz. Rated Z: 4. Power: min., 15. 20H x 11 $\frac{1}{2}$ "W x 9 $\frac{1}{4}$ "D. 44 lbs.\$88.

Advent/2

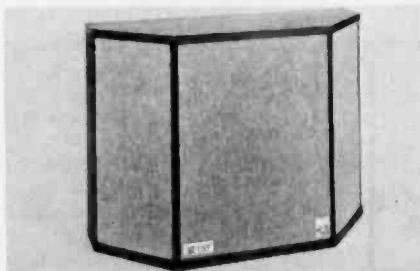
Acoustic suspension. 9" woofer, two 1 $\frac{3}{8}$ " tweeters. CF: 1,500 Hz. Rated Z: 8. Power: min., 10. 19H x 11 15/16W x 7 $\frac{1}{4}$ "D. 17 $\frac{1}{2}$ " lbs.\$74.



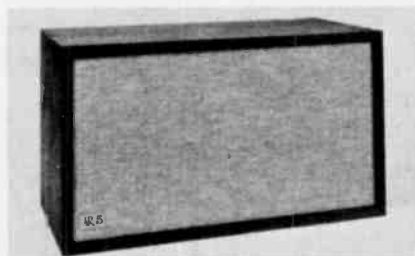
Acoustech SB-1



Acoustic Fiber Sound Systems KC35



Acoustic Research AR-LST



Acoustic Research AR-5

AKAI

S-82

8" woofer, 3" tweeter. CF: 4,000 Hz. Rated Z: 8. Power: max., 15. Response: 60-17,000 Hz \pm 5 dB, ref. 80 dB/SPL at 3.3 feet of 1 watt input power. 19H x 11W x 6 $\frac{3}{4}$ D. 9 $\frac{1}{2}$ lbs.\$69.95 per pair.

S-102

Ported. 10" woofer, 2" tweeter. CF: 2,000 Hz. Controls: high frequency. Rated Z: 8. Power: max., 40. Response: 45-20,000 Hz \pm 5 dB, ref. 85 dB/SPL at 3.3 feet for 1 watt input power. 24H x 13 $\frac{1}{4}$ W x 9 $\frac{3}{4}$ D. 27 lbs.\$89.95.

S-122

Ported. 12" woofer, 2" tweeter. CF: 2,000 Hz. Controls: high frequency. Rated Z: 8. Power: max., 40. Response: 45-20,000 Hz \pm 5 dB, ref. 86 dB/SPL at 3.3 feet for 1 watt input. 26 $\frac{3}{4}$ H x 14 $\frac{1}{4}$ W x 10 $\frac{1}{4}$ D. 34 lbs.\$125.

S-123

Ported. 12" woofer, 4 $\frac{1}{2}$ " midrange, 2" tweeter. CF: 1,500 Hz and 4,000 Hz. Controls: high frequency; midrange. Rated Z: 8. Power: max., 50. Response: 35-20,000 Hz \pm 5 dB, ref. 88 dB/SPL at 3.3 feet for 1 watt input power. 26 $\frac{3}{4}$ H x 14 $\frac{1}{4}$ W x 10 $\frac{1}{4}$ D. 40 lbs.\$179.95.

ALLISON ACOUSTICS

Allison One

Acoustic suspension. Two 10" woofers, two 3 $\frac{1}{2}$ " convex diaphragm midrange, two 1" convex diaphragm tweeters. CF: 350 Hz and 3,750 Hz. Controls: balance with three energy slope positions. Rated Z: 8. Power: min., 30; max., manufacturer claims will handle output of any amp intended for home use. 40H x 19W x 10 $\frac{1}{4}$ D. 67 lbs.\$360.

Allison Two

Same as Allison One except has two 8" woofers. 36H x 16W x 9 $\frac{3}{4}$ D. 57 lbs.\$295.

ALTEC

One

Acoustic suspension. 8" woofer, 4" cone tweeter. CF: 3,000 Hz. Controls: high frequency. Rated Z: 8. Power: min., 12; max., 30. Response: 50-20,000 Hz, ref. 84 dB/SPL at 4 feet. 21H x 11 $\frac{1}{2}$ W x 10 $\frac{1}{2}$ D. 23 lbs.\$89.

Three

Vented. 10" woofer, 4" cone tweeter. CF: 1,500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 35. Response: 50-20,000 Hz, ref. 90 $\frac{1}{2}$ dB/SPL at 4 feet. 24H x 12 $\frac{1}{2}$ W x 11 $\frac{1}{2}$ D. 26 $\frac{1}{4}$ lbs.\$119.

Five

Vented. 12" woofer, two 4" cone tweeters. CF: 1,500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 12; max., 45. Response: 45-20,000 Hz, ref., 91 $\frac{1}{2}$ dB/SPL at 4 feet. 25 $\frac{1}{4}$ H x 14 $\frac{1}{4}$ W x 12D. 32 lbs.\$169.

Seven

Vented. 12" woofer, 6 $\frac{1}{2}$ " cone midrange, 4" cone tweeter. CF: 850 Hz and 8,000 Hz. Controls: midrange and tweeter. Rated Z: 8.

Power: min., 15; max., 50. Response: 45-20,000 Hz, ref. 90 dB/SPL at 4 feet. Choice of grille colors. 25H x 16W x 14 $\frac{1}{4}$ D. 43 $\frac{3}{4}$ lbs.\$219.

Nine

Vented. 12" woofer, 6 $\frac{1}{2}$ " cone midrange, 5" cone tweeter. CF: 800 Hz and 7,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 12; max., 60. Response: 40-20,000 Hz, ref. 93 dB/SPL at 4 feet. Choice of grille colors. 26 $\frac{1}{2}$ H x 17 $\frac{1}{2}$ W x 15D. 56 lbs.\$289.

A7-8

Reflex port. 15" woofer, compression driver mounted to sectoral horn. CF: 800 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 50. Response: 45-20,000 Hz, ref. 101 dB/SPL at 4 feet. 52 $\frac{1}{4}$ H x 30W x 24D. 135 lbs.\$499.

A7-500-8

Same as Model A7-8 except: 142 lbs.\$530.

846B Valencia

Vented. 15" woofer, compression driver mounted to sectoral horn. CF: 800 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 50. Response: 40-20,000 Hz, ref. 97 $\frac{1}{2}$ dB/SPL at 4 feet. 29 $\frac{3}{4}$ H x 26 $\frac{1}{2}$ W x 20 $\frac{1}{4}$ D. 99 lbs.\$449.

873A Barcelona

Acoustic suspension. 15" woofer, compression driver mounted to sectoral horn. CF: 500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 20; max., 60. Response: 30-20,000 Hz, ref. 92 $\frac{1}{2}$ dB/SPL at 4 feet. 29 $\frac{3}{4}$ H x 38 $\frac{1}{2}$ W x 25D. 149 lbs.\$699.

878B Santiago

Acoustic suspension. 15" woofer, compression driver mounted to sectoral horn. CF: 800 Hz. Rated Z: 8. Power: min., 20; max., 60. Response: 35-20,000 Hz, ref. 92 $\frac{1}{2}$ dB/SPL, at 4 feet. With slate top. 30 $\frac{3}{4}$ H x 25 $\frac{3}{4}$ W x 18 $\frac{1}{2}$ D. 110 lbs.\$499.

879A Santana

Infinite baffle. 15" woofer, 4" cone tweeter. CF: 3,500 Hz. Rated Z: 8. Power: min., 12; max., 45. Response: 40-20,000 Hz, ref. 95 dB/SPL at 4 feet. 23 $\frac{3}{4}$ H x 20W x 17D. 52 lbs.\$269.

Stonehenge I

Vented. 12" woofer, 5" cone tweeter. CF: 1,800 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 45. Response: 50-20,000 Hz, ref. 90 dB/SPL at 4 feet. 37 $\frac{1}{2}$ H x 16W x 14 $\frac{1}{4}$ D. 75 lbs.\$299.

Stonehenge II

Vented. 12" woofer, 5 $\frac{1}{2}$ " cone midrange, 5" tweeter. CF: 500 Hz and 5,000 Hz. Controls:

separate midrange and tweeter. Rated Z: 8. Power: min., 20; max., 50. Response: 35-20,000 Hz, ref. 86 dB/SPL at 4 feet. 37 $\frac{1}{2}$ H x 16W x 14 $\frac{1}{4}$ D. 61 lbs.\$359.

Stonehenge III

Vented. 15" woofer with coaxially mounted horn and compression driver. CF: 1,500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 65. Response: 50-20,000 Hz, ref. 100 dB/SPL at 4 feet. 46H x 18 $\frac{3}{4}$ W x 17 $\frac{1}{4}$ D. 114 lbs.\$595.

AMERICAN MONITOR

Model 12

Ported. 12" woofer, 4 $\frac{1}{2}$ " midrange, 2" micro-tweeter. CF: 1,500 Hz and 7,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 60. Response: 35-20,000 Hz \pm 3 dB. Fuse protection. 14 $\frac{1}{2}$ H x 25 $\frac{1}{2}$ W x 11 $\frac{1}{2}$ D. 42 lbs.\$199.

Model 12XP

Ported. 12" woofer, 4 $\frac{1}{2}$ " midrange, two 2" micro-tweeters. CF: 1,500 Hz and 7,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 100. Circuit breaker. 15H x 26W x 16 $\frac{1}{2}$ D. 57 lbs.\$299.

ANALOG & DIGITAL SYSTEMS

L 400

Acoustic suspension. 7" woofer, 1" soft dome tweeter. CF: 1,500 Hz. Rated Z: 4. Power: min., 10; max., 35. 17 $\frac{1}{4}$ H x 10W x 8 $\frac{1}{2}$ D. 16 lbs.\$89.50.

L 500

Acoustic suspension. 8" woofer, 1" soft dome tweeter. CF: 1,500 Hz. Rated Z: 4. Power: min., 10; max., 40. 20H x 11 $\frac{1}{2}$ W x 9 $\frac{3}{4}$ D. 26 lbs.\$129.50.

L 700

Acoustic suspension. Two 7" woofers, 1" soft dome tweeter. CF: 1,500 Hz. Rated Z: 4. Power: min., 10; max., 40. 21 $\frac{1}{4}$ H x 12 $\frac{1}{4}$ W x 10 $\frac{1}{2}$ D. 32 $\frac{1}{2}$ lbs.\$169.50.

L 710

Acoustic suspension. Two 7" woofers, 2" soft dome midrange, 1" soft dome tweeter. CF: 550 Hz and 4,000 Hz. Rated Z: 4. Power: min., 10; max., 50. 21 $\frac{1}{4}$ H x 12 $\frac{1}{4}$ W x 10 $\frac{1}{2}$ D. 38 lbs.\$235.

L 810

Acoustic suspension. Two 8" woofers, 2" soft dome midrange, 1" soft dome tweeter. CF: 500 Hz and 4,000 Hz. Rated Z: 4. Power: min., 10; max., 60. 25 $\frac{1}{4}$ H x 14 $\frac{1}{4}$ W x 11 $\frac{1}{4}$ D. 53 lbs.\$320.

ADS 2001

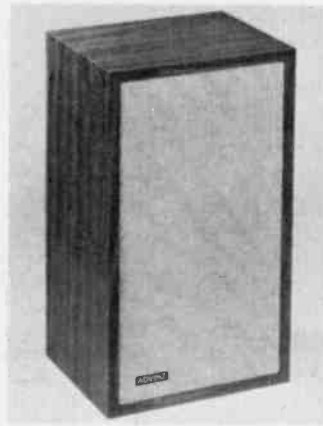
Acoustic suspension with built-in bi-amplification. 4" woofer, 1" dome tweeter. CF: 1,500 Hz. Controls: tweeter level. Rated Z: (amp input) 500 mV into 43,000 ohms and 5V into 350,000 ohms. Power: min., signal level from external preamp; max., built-in amps rated 60 watts per channel and 20 watts per channel. Miniature bi-amplified speaker system for use on 12 volt DC power source. 7H x 4W x 4D. 4 lbs. per speaker, 8 lbs. for four amps\$475.

How Should A Speaker Sound?

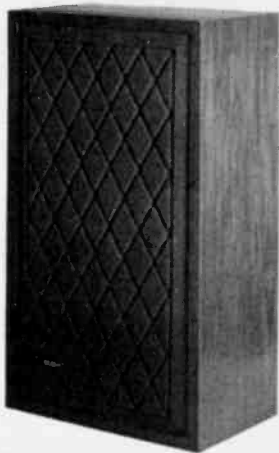
The extent to which a speaker produces no sound other than that which it is "ordered" to produce by the amplifier signal is a practical measure of its fidelity or accuracy. This quality is, to some extent, indicated by technical data but the ultimately true test is to listen to the speaker used in a sound playback system.



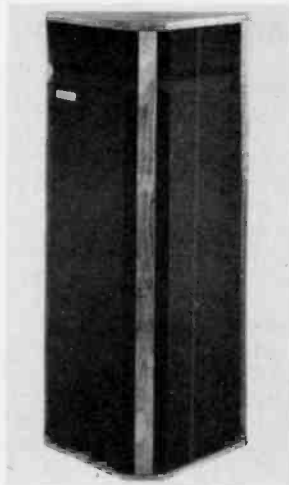
**Acoustic Research
Advanced Development Division AR-10**



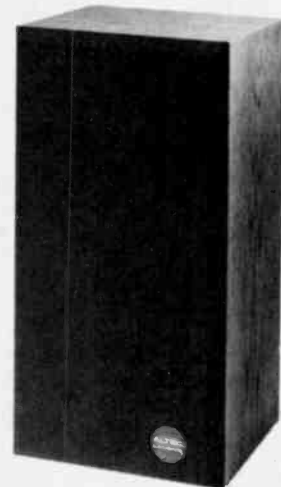
Advent "Smaller"



Akai S-122



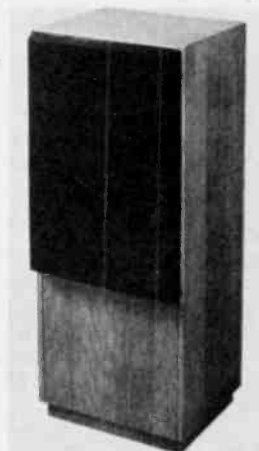
Allison One



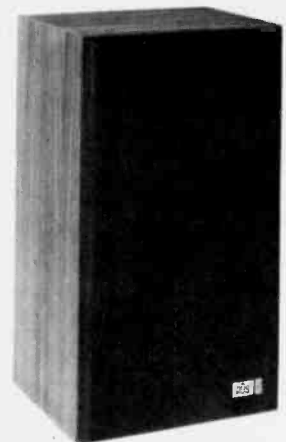
Altec Three



Altec 846B Valencia



Altec Stonehenge III



**Analog & Digital
Systems L710**

ARRAY

Array 3

Vented. Two 6½" midrange/woofers, 1" dome tweeter, CF: 3,500 Hz. Rated Z: 8. Power: min., 10; max., 100. Response: 27-22,000 Hz ± 2.5 dB, ref. 90 dB/SPL. Patented electronically tuned vent for extended bass. 22H x 15W x 12D. 32 lbs.\$375.

Array 12

Vented. Eleven 4½" midrange/woofers, 1" dome tweeter. CF: 3,500 Hz. Rated Z: 8. Power: min., 5; max., 350. Response: 20-22,000 Hz ± 2.5 dB, ref. 90 dB SPL. Patented electronically tuned vent for extended bass. 30½H x 17½W x 11½D. 66½ lbs.\$795.

AUDIOANALYST

A76X

Acoustic suspension. 10" woofer, 2" tweeter. CF: 1,800 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 10; max., 100. Response: 44-18,000 Hz ± 3 dB, ref. 90 dB at 1 meter. 21H x 12¼W x 10½D. 30 lbs.\$94.

A100X

Acoustic suspension. 10" woofer, 2" midrange, 1½" tweeter. CF: 1,500 Hz and 7,500 Hz. Controls: midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 100. Response: 40-20,000 Hz ± 3 dB, ref. 92 dB at 1 meter. Manufacturer claims 160 degree dispersion at 15,000 Hz. 24¾H x 13¾W x 12D. 37 lbs.\$138.

A200X

Acoustic suspension. 12" woofer, 5" midrange, 2" tweeter, two 1½" super-tweeters. CF: 800 Hz, 2,000 Hz, and 7,500 Hz. Controls: midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 100. Response: 38-22,000 Hz ± 3 dB ref. 94 dB at 1 meter. 27H x 15W x 12¾D. 53 lbs.\$249.

Tower of Sound

Acoustic suspension. Two 10" woofers, two 2" midrange, two 1½" tweeters. CF: 1,500 Hz and 7,500 Hz. Controls: Two midrange and two tweeter level switches. Rated Z: 4. Power: min., 20; max., 200. Response: 38-20,000 Hz ± 3 dB, ref. 94 dB at 1 meter. Vertically stacked A100Xs; lower unit inverted. 48¾H x 13¾W x 12D. 74 lbs.\$276.

AUDIO DYNAMICS

New Milford I

Acoustic suspension. 10" woofer. 2½" cone tweeter. CF: 1,500 Hz. Controls: tweeter. Rated Z: 8. Power: min., 5; max., 30. Response: 45-20,000 Hz ± 3 dB. 22½H x 13W x 11D. 35 lbs.\$99.95.

New Milford II

Acoustic suspension. 10" woofer, 2½" midrange, 1½" tweeter. CF: 1,100 Hz and 5,000 Hz. Controls: midrange and tweeter levels. Rated Z: 8. Power: min., 10; max., 30. Response: 45-20,000 Hz ± 3 dB. 25H x 12¾W x 11½D. 37 lbs.\$199.95.

New Milford III

Acoustic suspension. 12" woofer, 1½" dome midrange, ½" tweeter. CF: 900 Hz and 5,000 Hz. Controls: rotary selector for midrange

and/or high end. Rated Z: 8. Power: min., 10; max., 50. Response: 37-20,000 Hz ± 3 dB. 25H x 12¾W x 11½D. 39 lbs.\$299.95.

XT6

Acoustic suspension. 6" woofer, 2½" cone tweeter. CF: 1,400 Hz. Rated Z: 6. Power: min., 3; max., 12.5. Response: 42-20,000 Hz ± 3 dB. 12¾H x 8½W x 7¾D. 10 lbs.\$69.95.

XT9

Acoustic suspension. 10" woofer, 2½" cone tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 45-20,000 Hz ± 3 dB. 23¾H x 13W x 11¾D. 35 lbs.\$89.

XT10

Acoustic suspension. 10" woofer, two 2½" cone tweeters. CF: 1,500 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 37-20,000 Hz ± 3 dB. 23¾H x 13W x 11¾D. 40 lbs.\$115.

303AX

Acoustic suspension. 10" woofer, two 2½" cone tweeters. CF: 1,400 Hz. Controls: midrange and treble switches. Rated Z: 8. Power: min., 10; max., 30. Response: 37-20,000 Hz ± 3 dB. 23¾H x 13W x 11¾D. 37 lbs.\$100.

AUDIO RESEARCH

Magneplanar Tympani III-A

Dipole radiation. Mylar film, two 2-section screens, 4-section screen. CF: 100 Hz and 1,600 Hz. Rated Z: 8. Power: min., two 50 watt RMS per channel amps; max., two 300 watt RMS per channel amps. Response: 38-20,000 Hz ± 4 dB. Must be biamplified, may be triamplified. Each section 72H x 16W x 1D. 195 lbs.\$1,695 per pair.

Magneplanar Tympani I-B

Dipole radiator. Mylar film, two 3-section screens. CF: 1,600 Hz. Rated Z: 8. Power: min., 50; max., 350. Response: 45-18,000 Hz ± 3 dB. May be biamplified. Each section 72H x 16W x 1D. 160 lbs.\$1,155 per pair.

AUDIONICS

M-32

Resistive slot loading. KEF B200 8" woofer, two tweeters. Rated Z: 8. Power: min., 20; max., 100. Response: 50-16,000 Hz ± 4 dB, ref. 85 dB at 1 meter. 21H x 11W x 11D. 35 lbs.\$150.

M-33

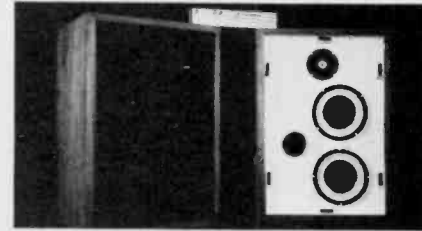
Resistive slot loading. 9" x 13" woofer, 5" midrange, ¾" dome tweeter. CF: 300 Hz and 3,500 Hz. Rated Z: 8. Power: min., 20; max., 150. Response: 38-22,000 Hz ± 4 dB. 30H x 16W x 14D. 90 lbs.\$330.

TL30-B

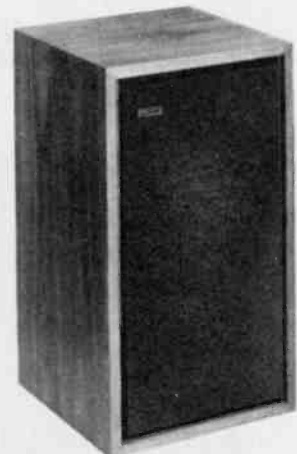
Acoustic transmission line. Three 8" KEF woofers, two miniature cone tweeters. CF: 2,200 Hz. Controls: high-frequency level. Rated Z: 8. Power: min., 20; max., in excess of 75 watts program material. Response: 45-16,000 Hz ± 4 dB, ref. 85 dB/SPL. 40H x 11W x 11½D. 65 lbs.\$199.

TL90

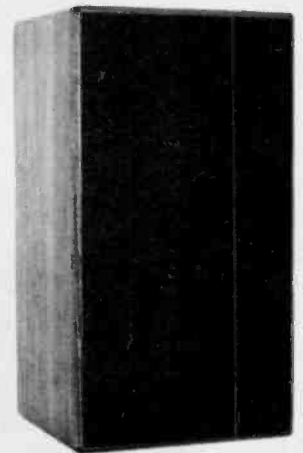
Transmission line. Radford 10" elliptical woofer, midrange unit, and 1" dome tweeter. CF: 500 Hz and 4,500 Hz. Controls: not speci-



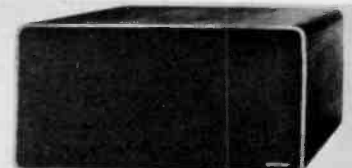
Array 3



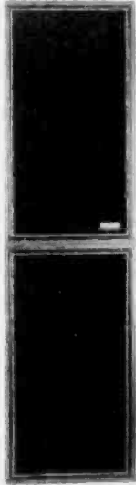
Audio Dynamics XT6



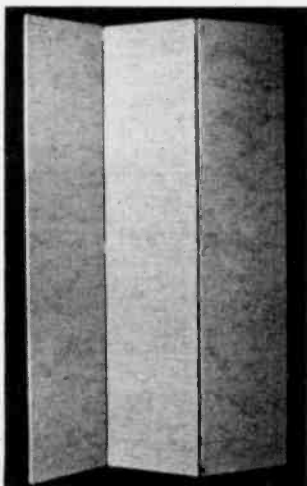
Audlonics M-33



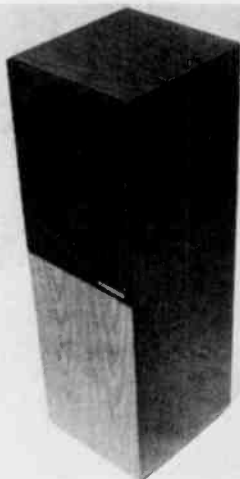
Audloson Kirksaeter
Monitor 40



Audioanalyst
"Tower of Sound"



Audio Research
Magneplanar Tympani III-A



Audionics TL90

fied. Rated Z: 8. Power: min., 20; max., 100. Response: 38-20,000 Hz \pm 4 dB. 44H x 13½W x 14½D. 110 lbs.\$449.

TL90W Mk II

Transmission line. Woofer only. Rated Z: 8. Power: min., 25; max., 200. Response: 30-20,000 Hz \pm 3½ dB. Manufacturer stated this is a "sub-woofer system for use with Magneplanar, full-range electrostatics, and other high-performing systems requiring low-frequency enhancement." 50H x 16½W x 16½D. 120 lbs.\$300.

TLM-200

Transmission line. Drivers same as in M-33. CF: 300 Hz and 3,500 Hz. Rated Z: 8. Power: min., 25; max., 150. Response: 32-22,000 Hz \pm 3½ dB. Supplied in mirror image or matched pairs. 50H x 16W x 14D. 140 lbs.\$525.

AUDIOSON

Kirksaeter Monitor 35

Acoustic suspension. 8" woofer, 1" tweeter. CF: 3,500 Hz. Rated Z: 4. Power: min., 10; max., 35. Response: 30-20,000 Hz. Available in walnut, black, or white cabinet. 9½H x 18W x 8D. 14 lbs.\$130.

Kirksaeter Monitor 40

Acoustic suspension. 8" woofer, 1½" midrange, 1" tweeter. CF: 1,200 Hz and 5,500 Hz. Rated Z: 4. Power: min., 15; max., 40. Response: 28-22,000 Hz. Available in walnut, black, or white. 9½H x 18W x 8D. 18 lbs. \$165.

Kirksaeter Monitor 45

Acoustic suspension. 10" woofer, 1" tweeter. CF: 3,500 Hz. Rated Z: 4. Power: min., 10; max., 45. Response: 28-20,000 Hz. Available in walnut, black, or white. 9¾H x 18W x 11½D. 16 lbs.\$160.

Kirksaeter Monitor 50

Acoustic suspension. 10" woofer, 1½" midrange, 1" tweeter. CF: 1,200 Hz and 5,500 Hz. Rated Z: 4. Power: min., 25; max., 50. Response: 22-22,000 Hz. Available in walnut, black, or white. 9¾H x 18W x 11½D. 22 lbs.\$210.

Kirksaeter Monitor 70

Acoustic suspension. 12" woofer, 1½" midrange, 1" tweeter. CF: 1,200 Hz and 5,500 Hz. Rated Z: 4. Power: min., 30; max., 70. Response: 20-22,000 Hz. Available in walnut, black, or white. 13H x 22½W x 11D. 40 lbs.\$300.

Monitor 100

Acoustic suspension. Two 10" woofers, two 1½" midrange, two 1" tweeters. CF: 1,200 Hz and 5,500 Hz. Rated Z: 4. Power: min., 35; max., 100. Response: 18-22,000 Hz. Available in walnut, black, or white. 29½H x 15½W x 12D. 66 lbs.\$450.

AUDIOTEX

Audio Trek I

Air suspension. 6" cone woofer, 3" tweeter. Rated Z: 8. Power: min., 5; max., 20. Response: 50-20,000 Hz. 5-yr. warranty. 17H x 10W x 6D. 11½ lbs.Price not available.

Audio Trek II

Air suspension. 8" cone woofer, 1¾" tweeter. Rated Z: 8. Power: min., 5; max., 25. Response: 35-22,000 Hz. 5-yr. warranty. 18½H x 11¼W x 7½D. 14 lbs.Price not available.

Audio Trek III

Air suspension. 10" woofer, 2¾" tweeter. Rated Z: 8. Power: min., 10; max., 35. Response: 40-22,000 Hz. 5-yr. warranty. 20H x 12W x 10D. 20 lbs.Price not available.

Audio Trek IV

Air suspension. 12" woofer, 4½" midrange, 1¾" tweeter. Rated Z: 8. Power: min., 10; max., 45. Response: 35-22,000 Hz. 24H x 15W x 10D. 29 lbs.Price not available.

AVID

Model 60

Bass reflex. 9" x 6" elliptical woofer, 2½" cone tweeter. CF: mechanical, 1,600 Hz and 8,000 Hz. Rated Z: 8. Power: min., 5; max., 35. Response: 60-17,000 Hz \pm 5 dB, ref. 90 dB at 1 meter. Brown or cream color grille. wall brackets supplied, 5-yr. warranty. 27½H x 8¾W x 8 5/16D. 16 lbs.\$125 per pair.

Model 100

Air suspension. 8" woofer, 1¾" tweeter. CF: 2,500 Hz. Controls: 3-position step switch (front mounted). Rated Z: 8. Power: min., 15; max., 75. Response: 40-18,000 Hz \pm 5 dB, ref. 85 dB at 1 meter. User-changeable grilles (8 colors), 5-yr. warranty. 21H x 12¾W x 8½D. 22 lbs.\$88.

Model 102

Air suspension. 10" woofer, 1" dome tweeter. CF: 2,200 Hz. Controls: 3-position step switch (front mounted). Rated Z: 8. Power: min., 15; max., 100. Response: 35-18,000 Hz \pm 5 dB, ref. 85 dB at 1 meter. User-changeable grilles (8 colors), 5-yr. warranty, fuse protection. 25H x 15W x 9¾D. 36 lbs.\$130.

Model 103

Air suspension. 10" woofer, 4½" cone midrange, 1" dome tweeter. CF: 500 Hz and 3,500 Hz. Controls: 5-position step switch for mid and high frequencies. Rated Z: 8. Power: min., 20; max., 150. Response: 35-18,000 Hz \pm 5 dB, ref. 84 dB at 1 meter. 1¾" floor stand supplied, user-changeable grilles (8 colors), fuse protection, 5-yr. warranty. 25H x 15W x 9¾D. 38 lbs.\$165.

Model 105

Air suspension. 12" woofer, 3" midrange cone, two 1¾" cone tweeters (auxiliary), 1" dome tweeter. CF: 500 Hz and 4,000 Hz. Controls: 3-position step switches for mid and high frequencies. Rated Z: 8. Power: min., 20; max., 200. Response: 30-18,000 Hz \pm 3 dB, ref. 84 dB at 1 meter. Manufacturer claims 180 degree dispersion to 15,000 Hz, 5-yr. warranty, fuse protection. 26½H x 20W x 15D. 76 lbs.\$300.

BANG & OLUFSEN

Beovox S-45

Acoustic suspension. 8" woofer, 3½" "filler driver," 1" dome tweeter. CF: 2,000 Hz. Rated Z: 4-8. Power: min., 15; max., 45. Response: 38-20,000 Hz +4/-8 dB. 18½H x 10¼W x

7½D. 15½ lbs.\$135.

Beovox S-60

Acoustic suspension. 10" woofer, 5" "filler driver," 2" midrange, 1" dome tweeter. CF: 700 Hz and 4,000 Hz. Rated Z: 4-8. Power: min., 15; max., 60. Response: 36-20,000 Hz +4/-8 dB. 23¼H x 12¾W x 7¾D. 24¼ lbs.\$195.

Beovox M-70

Acoustic suspension. 10" woofer, 5" "filler driver," 2½" midrange, 1" dome tweeter. CF: 500 Hz and 4,500 Hz. Rated Z: 4-8. Power: min., 15; max., 70. Response: 27-20,000 Hz +4/-8 dB. 25¾H x 13¾W x 11¾D. 55 lbs.\$295.

BES

D-50

Geostatic. Two electromagnetic drivers. CF: 3,000 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 60. Response: 45-20,000 Hz ± 4 dB. Manufacturer claims 360 degree dispersion. Speaker: 26H x 16W x 3¾D; base: 1H x 18W x 10D.\$99.

D-60

Geostatic. Three electromagnetic drivers. CF: 700 Hz and 3,000 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 150. Response: 38-20,000 Hz ± 2 dB. Manufacturer claims 360 degree dispersion. Speaker: 29¾H x 20¼W x 3¾D; base: 1H x 18W x 10D.\$199.

D-120

Geostatic. Four electromagnetic drivers. CF: 700 Hz and 3,000 Hz. Controls: mid and high frequencies. Rated Z: 4. Power: min., 10; max., 250. Response: 35-22,000 Hz ± 2 dB. Manufacturer claims 360 degree dispersion. Speaker: 53¾H x 20¼W x 3¾D; base: 1H x 18W x 10D.\$399.

U-60

Geostatic. Two electromagnetic drivers. CF: 900 Hz. Rated Z: 8. Power: min., 10; max., 100. Response: 38-18,000 Hz ± 3 dB. Manufacturer claims 360 degree dispersion. Speaker: 26½H x 17¾W x 3¾D; base: 1H x 18W x 10D.\$149.

HAROLD BEVERIDGE

Beveridge Cylindrical Sound System Model 2

Full-range electrostatic. Controls: spectrum slope. Rated Z: integral direct-coupled amp to capacitive load of 5,000 pF. Response: 40-15,000 Hz ± 2 dB. Manufacturer claims 180-degree dispersion at all frequencies. 78H x 24W x 16D. 70 lbs. \$4,000 per pair, with amps.

BIC VENTURI

Formula 1

Venturi-coupled bass. 8" woofer; biconex horn/compression driver for mid/treble frequency. CF: 1,500 Hz. Controls: brightness. Rated Z: 6. Power: min., 10; max., 50. Re-

sponse: 50-18,000 Hz ± 6 dB, ref. 90 dB/SPL at 1 meter. Choice of grille color. 15H x 10¾W x 10D. 20 lbs.\$74.95.

Formula 2

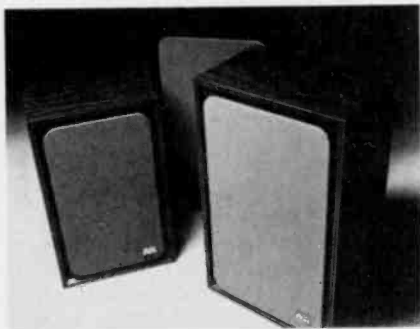
Venturi-coupled bass. 8" woofer, biconex horn/compression-drive midrange, dome-type super-tweeter. CF: 1,500 and 15,000 Hz. Controls: auto/manual dynamic tonal compensation switch; brightness. Rated Z: 6. Power: min., 10; max., 75. Response: 40-20,000 Hz ± 6 dB/SPL at 1 meter. Manufacturer claims 120-degree dispersion in horizontal or vertical plane; choice of grille color. 19¾H x 12W x 11½D. 26 lbs.\$112.50.

Formula 4

Venturi-coupled bass. 10" woofer, biconex horn/compression-drive midrange, dome-type super-tweeter. CF: 1,500 Hz and 15,000 Hz. Controls: auto/manual dynamic tonal compensation switch; brightness. Rated Z: 6. Power: min., 8; max., 100. Response: 35-20,000 Hz ± 6 dB, ref. 93 dB/SPL at 1 meter. Manufacturer claims 120-degree dispersion in horizontal or vertical plane; choice of grille color. Optional pedestal base (VB-4). 25H x 13¼W x 13D, 40 lbs.\$149.95.

Formula 6

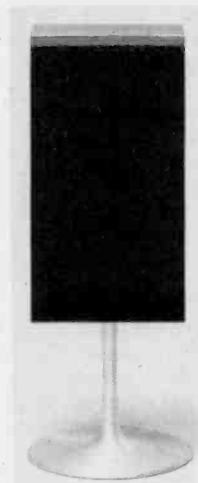
Venturi-coupled bass. 12" woofer, 5" cone-type midrange (isolated), two biconex horn/compression drivers, two dome-type super-tweeters. CF: 750 Hz, 1,500 Hz, and 15,000 Hz. Controls: auto/manual dynamic tonal compensation switch; brightness. Rated Z: 6. Power: min., 5-8; max., 125. Response:



Avid Model 100



Braun LV 1020



Bang & Olufsen Beovox M-70



Avid Model 105

30-20,000 Hz \pm 6 dB, ref. 9 dB/SPL at 1 meter. Manufacturer claims 160 degree dispersion in vertical or horizontal plane; choice of grille color. Optional pedestal base (VB-6). 26 $\frac{1}{4}$ "H x 15 $\frac{1}{4}$ "W x 14 $\frac{1}{4}$ "D. 57 lbs.....\$273.25.

BML ELECTRONICS

Tracer I

Terminated transmission line. 7 $\frac{1}{2}$ " woofer, 6 $\frac{1}{2}$ " ABR (auxiliary bass radiator), 3" piezoelectric tweeter. Rated Z: 4. Power: min., 6; max., 100. Response: 43-23,000 Hz \pm 3 dB. Fuse protection, lifetime warranty on drivers. 22H x 12W x 10D. 30 lbs.....\$112.

Tracer II

Terminated transmission line. 7 $\frac{1}{2}$ " woofer, 7 $\frac{1}{2}$ " ABR, two 3" piezoelectric tweeters. Rated Z: 4. Power: min., 12; max., 180. Response: 38-23,000 Hz \pm 3 dB. Fuse protection, lifetime warranty on drivers. 24 $\frac{1}{2}$ "H x 14 $\frac{1}{2}$ "W x 9D. 38 lbs.....\$149.95.

Tracer III

Terminated transmission line. 7 $\frac{1}{2}$ " woofer, 7 $\frac{1}{2}$ " ABR, 5" midrange, 3" piezoelectric horn tweeter. Rated Z: 4. Power: min., 20; max., 200. Response: 28-20,000 Hz \pm 1.5 dB. Fuse protection, lifetime warranty on drivers. 26H x 14W x 12 $\frac{1}{2}$ "D. 41 lbs.....\$299.95.

BOSE

301

Ducted port bass reflex. 8" woofer, 3" tweeter.

CF: 1,200 Hz and 3,000 Hz (woofer and tweeter frequency response overlap by over one octave). Controls: "Direct energy" (for setting balance of reflected to direct sound at high frequencies). Rated Z: 8. Power: min., 10; max., 60. Manufacturer claims flat power radiation; tweeter reflects off side wall. 10 $\frac{1}{2}$ "H x 17W x 9 $\frac{1}{2}$ "D. 18 lbs.\$96, sold in pairs only.

501

Acoustic suspension. 10" woofer, two 3 $\frac{1}{2}$ " tweeters. CF: 1,500 Hz. Rated Z: 4. Power: min., 15; max., 100. Tweeters reflect off wall behind speaker. 24H x 14 $\frac{1}{2}$ "W x 14 $\frac{1}{2}$ "D. 42 lbs.....\$168.

901

Acoustic suspension with active equalization. Nine 4 $\frac{1}{2}$ " drivers. Controls on equalizer: tape monitor switch, 2-position bass contour, 10-position treble. Rated Z: 8. Power: min., 25; max., 270. 12 $\frac{3}{4}$ "H x 20 $\frac{9}{16}$ "W x 12 $\frac{1}{2}$ "D. 33 lbs.....\$598 per pair including equalizer.

How Should A Speaker Sound?

The extent to which a speaker produces no sound other than that which it is "ordered" to produce by the amplifier signal is a practical measure of its fidelity or accuracy. This quality is, to some extent, indicated by technical data but the ultimately true test is to listen to the speaker used in a sound playback system.

BOZAK

Sonora, B-201

Vented enclosure. 8" bass/midrange, 2" tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 12; max., 60. Response: 45-20,000 Hz. 11 $\frac{1}{4}$ "H x 20 $\frac{1}{4}$ "W x 10D. 30 lbs.\$99.50.

Tempo II, B-301B and B-301F

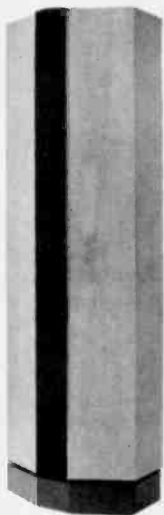
Sealed enclosure. 12" bass, 4 $\frac{1}{2}$ " midrange, 2" tweeter. CF: 1,200 Hz and 3,600 Hz. Controls: 3-way treble switch. Rated Z: 8. Power: min., 15; max., 50. Response: 40-20,000 Hz. B-301B finished all sides in simulated walnut vinyl; B-301F finished in genuine walnut veneer, on black pedestal base. Both with sculptured foam grilles. B-301B: 23 $\frac{1}{4}$ "H x 14 $\frac{1}{2}$ "W x 11 $\frac{1}{2}$ "D; B-301F: 24 $\frac{1}{4}$ "H x 14 $\frac{1}{2}$ "W x 11 $\frac{1}{2}$ "D. 40 lbs.\$165.50; B-301F, \$188.50.

Rhapsody, B-401 and B-402

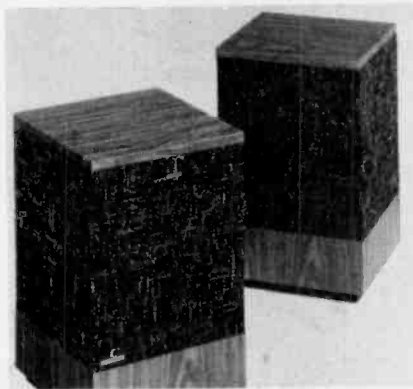
Sealed enclosure. 12" bass, 6 $\frac{1}{2}$ " midrange, two 2" tweeters. CF: 800 Hz and 2,500 Hz. Controls: 3-way treble switch. Rated Z: 8. Power: min., 15; max., 60. Both models in genuine walnut veneer; B-401 with sculptured foam grille and black pedestal base for floor mounting; B-402 finished all sides for shelf mounting and with changeable fabric grille. B-401: 25 $\frac{1}{2}$ "H x 18W x 13 $\frac{1}{4}$ "D; B-402: 18H x 25 $\frac{1}{2}$ "W x 13 $\frac{1}{4}$ "D. 65 lbs.....\$283.

Monitor C, B-407

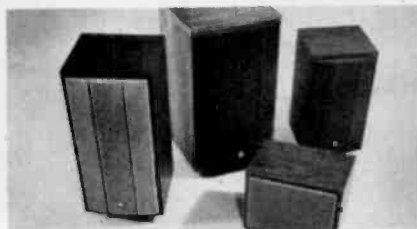
Infinite baffle. Four 8" bass/midrange, eight 2" tweeters. CF: 2,000 Hz. Controls: 3-way treble switch. Rated Z: 8. Power: min., 40;



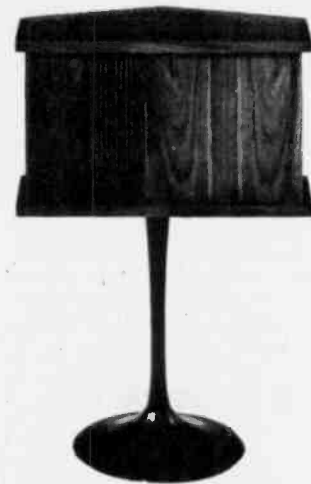
Harold Beveridge
Model 2



Bose 501



Bic Venturi Formula 1



Bose 901

max., 150. Response: 35-20,000 Hz. 41H x 18½W x 15¼D. 100 lbs.\$514.

Concert Grand, B-410 Classic

Infinite baffle. Four 12" bass, two 6½" mid-range, eight 2" treble. CF: 400 Hz and 2,500 Hz. Rated Z: 8. Power: min., 60; max., 150. Response: 28-20,000 Hz. Two other cabinet styles available; may be wired for bi-amplification on special order. 52H x 36W x 19D. 225 lbs.\$1,195.50.

The Bard, B-1000A

Sealed enclosure. 8" wide range. Rated Z: 8. Power: min., 12; max., 60. Complete weatherproof high-quality system for outdoor use the year round. Available in white or beige enamel finish. 18 inches in diameter; 21H x 12D. 25 lbs.\$99.50.

Symphony No. 1, B-4000A, Modern

Infinite baffle. Two 12" bass, 6½" midrange, eight 2" treble. CF: 400 Hz and 2,500 Hz. Rated Z: 8. Power: min., 50; max., 100. Response: 35-20,000 Hz. Two other cabinet styles available. May be wired for bi-amplification on special order. 44½H x 26¼W x 15¼D. 165 lbs.\$664.

Symphony No. 2, B-4005, Moorish

Infinite baffle. Two 12" bass; 6½" midrange, eight 2" treble. CF: 400 Hz and 2,500 Hz. Rated Z: 8. Power: min., 50; max., 100. Response: 35-20,000 Hz. One other cabinet style available. May be wired for bi-amplification on special order. 30H x 36¼W x 18¼D. 190 lbs.\$795.

BRAUN

Braun LV 1020

Acoustic suspension with built-in tri-amplification. 12" woofer, 2" soft dome midrange, 1" soft dome tweeter. CF: 400 Hz and 3,000 Hz. Controls: sensitivity; bass; midrange; tweeter level. Rated Z: (amp input) 50,000. Power: min., signal level from external preamp.; max., built-in. Includes three power amplifiers (55, 30, 15 watts), electronic crossover networks, and power supplies. 29½H x 15W x 11¼D. 61½ lbs.\$789.

CELESTION SPEAKERS

Received too late for inclusion in the directory was news of the line of British-made Celestion speaker systems. There are eight models in all, priced from \$139.50 to \$469.50, of various sizes, configurations, and power handling ability. North American distributor is Rocelco, Inc., 160 Ronald Drive, Montreal, Canada H4X 1M8.

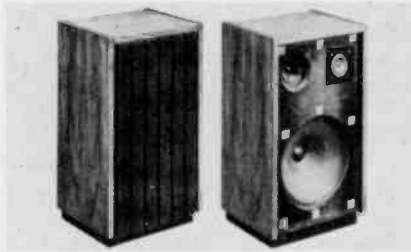
CERWIN-VEGA

12T "Tower"

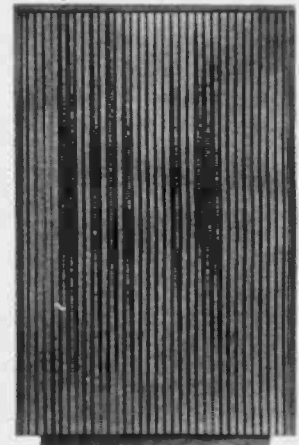
"Labryflex" (modified transmission line—rear ducted). 12" (floor-facing) woofer, 8" midrange (in sealed sub-chamber), 2½" "dhorm" tweeter. CF: 200 Hz and 4,000 Hz. Controls: separate midrange and high frequency level. Rated Z: 8. Power: min., 4; max., 100. Response: 30-20,000 Hz ± 3 dB, ref. 100 dB at 1 meter. 40H x 13½W x 13½D. 75 lbs.\$299.50.

15T "Tower"

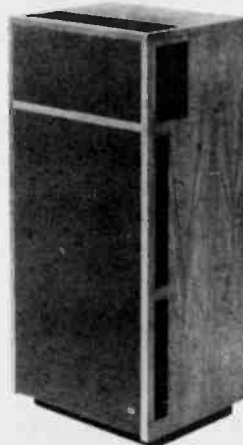
"Labryflex" high efficiency. 15" (floor-facing)



Bozak Tempo II



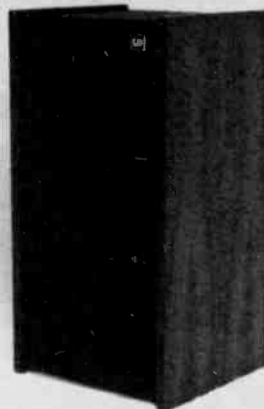
Bozak Symphony No. 1



Bozak Monitor C



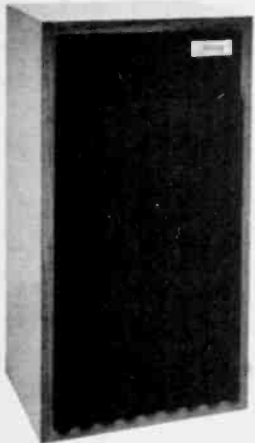
Cerwin-Vega 15T "Tower"



CJD 300x



C M Labs CM-15



Concord CS-10



Cerwin-Vega 25



Coast Systems Image 99

woofer, 8" midrange (in sealed sub-chamber rear-reflecting horn midrange), 5" super-"dhorm" tweeter. CF: 200 Hz, 1,500 Hz, and 4,000 Hz. Controls: separate front mid (8"), rear mid, and tweeter level. Rated Z: 8. Power: min., 3; max., 150. Response: 32-20,000 Hz \pm 3 dB on axis, ref. 103 at 1 meter. 41H x 16½W x 16½D. 90 lbs.\$495.

25

Ducted reflex. 12" high-energy woofer, 1" dome tweeter. CF: 2,500 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 5; max., 40. Response: 38-20,000 Hz \pm 3½ dB, ref. 95 dB at 1 meter. 25H x 14½W x 12D. 40 lbs.\$139.50.

36R

Modified bass reflex/transmission line, rear-ducted. 12" woofer, 4½" rear-reflecting midrange, 2½" "dhorm" tweeter. CF: 600 Hz and 2,500 Hz. Controls: direct/reflex balance for use as 2-way all-front radiating system or 3-way reflection system, or any point in between. Rated Z: 8. Power: min., 5; max., 60. Response: 35-20,000 Hz \pm 3½ dB, ref. 96 dB at 1 meter. 25H x 14½W x 12D. 50 lbs.\$169.50.

311

"Labryflex" (modified transmission line—bottom-ducted). 12" woofer, 8" midrange (in sealed sub-chamber), 2½" "dhorm" tweeter. CF: 200 Hz and 4,000 Hz. Controls: separate midrange and high frequency level. Rated Z: 8. Power: min., 4; max., 100. Response: 32-20,000 Hz \pm 3 dB, ref. 100 dB at 1 meter. Supplied with runners to allow port radiation to escape when floor-mounted; can be wall-mounted. 26H x 16W x 16D. 65 lbs.\$219.50.

317

"Labryflex." 15" woofer, 8" midrange (in sealed sub-chamber), 5" super-"dhorm" tweeter. CF: 200 Hz and 4,000 Hz. Controls: mid- and high-frequency levels. Rated Z: 8. Power: min., 3; max., 150. Response: 30-20,000 Hz \pm 3 dB, ref. 103 dB at 1 meter on axis. Designed for wall-mounting as is; floor-mounting with optional runners (supplied). 27½H x 20W x 17D. 75 lbs.\$395.

CJD SOUND SYSTEMS

100x

Air suspension. 8" woofer, 1½" tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 5; max., 40. Response: 40-18,000 Hz \pm 5 dB. 10-yr. warranty. 19H x 11W x 9D. 20 lbs.\$59.

300x

Tuned port. CF: 1,300 Hz. Controls: high frequency. Rated Z: 8. Power: min., 5; max., 70. Response: 38-20,000 Hz \pm 5 dB. 10-yr. warranty. 24H x 13W x 11D. 30 lbs.\$89.

400x Column

Tuned port. 10" woofer, two 2¼" tweeters. CF: 1,300 Hz. Controls: high-frequency brilliance and ambience. Rated Z: 8. Power: min., 10; max., 100. Response: 32-21,000 Hz \pm 4 dB. Rosewood optional at extra cost. 10-yr. warranty. 41H x 11W x 9D. 56 lbs.\$209.

C M LABS

CM-15

Phase-sensing feedback system. 15" woofer,

6" midrange, two 2" phenolic ring tweeters, peizo-electric super-tweeter. CF: 450 Hz, 5,000 Hz, and 12,000 Hz. Controls: midrange, tweeter, and 3-position room gain switch. Rated Z: 4. Power: min., 40; max., 200. Response: 20-20,000 Hz \pm 3 dB. 5-yr. warranty, non-diffracting array for midrange and tweeter. 32H x 17W x 17D. 97 lbs.\$550.

COAST SYSTEMS

Image 44

Sealed. 8" woofer, phenolic ring tweeter. Rated Z: 8. Power: min., 15; max., 40. Response: 55-17,000 Hz. 19½H x 11¼W x 8½D. 17½ lbs.\$44.

Image 66

Bass reflex. 10" woofer, phenolic ring tweeter. CF: 3,300 Hz. Controls: bass and treble. Rated Z: 8. Power: min., 10; max., 40. Response: 40-18,000 Hz. Two-tone grille, speaker baffle finish is walnut. 25½H x 14¼W x 11½D. 40 lbs.\$104.

Image 99

Bass reflex. 12" woofer, 4½" midrange, phenolic ring tweeter. CF: 1,500 Hz and 5,000 Hz. Controls: bass, midrange, and treble. Rated Z: 8. Power: min., 20; max., 45. Response: 35-20,000 Hz. Two-tone grille, speaker baffle walnut finish. 25½H x 14½W x 12D. 39 lbs.\$139.

Image 55

Ported. 8" woofer, 1¼" dome tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 10; max., 40. Response: 50-17,000 Hz. Two-tone grille, speaker baffle walnut finish. Approx. 35 lbs. 23H x 12W x 9D.\$74.

COMMUNITY ELECTRONICS

102V/102W

Acoustic suspension. 10" woofer, 1¼" cone tweeter. CF: 1,600 Hz. Rated Z: 4. Power: min., 7; max., 150. Response: 35-18,500 Hz \pm 3 dB. 25H x 15½W x 13D. 38 lbs. 102V (black pebble grained vinyl), \$105; 102W, \$125.

124

Ducted port. 12" woofer, 3½" cone midrange, 1" dome tweeter, piezoelectric super-tweeter. CF: 530Hz, 4,200 Hz, and 12,000 Hz. Rated Z: 4. Power: min., 15; max., 400. Response: 26-25,000 Hz \pm 3 dB. 46½H x 16½W x 17½D. 105 lbs.\$225.

CONCORD PRODUCTS BENJAMIN ELECTRONIC SOUND CO.

CS-10

Resistive slot loading. 8" woofer, 3½" tweeter. CF: 3,500 Hz. Rated Z: 8. Power: min., 5; max., 40. Response: 50-18,000 Hz \pm 3 dB. 23¼H x 12¾W x 11¾D. 34 lbs.\$89.95.

CS-20

Resistive slot loading. Two 8" woofers, 3½" tweeter. CF: 3,500 Hz. Controls: 2-position midrange and tweeter switches. Rated Z: 8. Power: min., 5; max., 80. Response: 40-18,000 Hz \pm 3 dB. 24¾H x 13¾W x 11¾D. 40 lbs.

CREATIVE ENVIRONMENTS

89T

Ported. Two 5" woofers, two 3" tweeters. CF: 2,000 Hz. Rated Z: 8. Power: min., 15; max., 40. Response: 40-18,000 Hz \pm 5 dB, ref. 100 dB/SPL at 18 inches. Circuit breaker. 35H x 9W x 9D. 42 lbs.\$159.95.

100

Air suspension. 12" woofer, 5" cone midrange, 1" dome super-tweeter. CF: 700 Hz and 3,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 15; max., 50. Response: 30-20,000 Hz \pm 4 dB, ref. 107 dB/SPL at 18 inches. Fuse protection. 23 $\frac{3}{4}$ H x 14 $\frac{1}{4}$ W x 12 $\frac{1}{4}$ D. 45 lbs.\$219.95.

771

Air suspension. 10" woofer, 4" midrange, 2 $\frac{1}{2}$ " tweeter. CF: 4,000 Hz and 8,000 Hz. Rated Z: 8. Power: min., 15; max., 40. Response: 35-19,000 Hz \pm 7 dB, ref. 105 dB/SPL at 18 inches. Fuse protection. 22H x 12 $\frac{3}{4}$ W x 9 $\frac{1}{2}$ D. 28 lbs.\$119.95.

881

Air suspension. 12" woofer, 6" midrange, 2 $\frac{1}{2}$ " tweeter. CF: 1,000 Hz and 4,000 Hz. Rated Z: 8. Power: min., 15; max., 40. Response: 30-20,000 Hz \pm 7 dB, ref. 102 dB/SPL at 18 inches. Fuse protection. 23 $\frac{3}{4}$ H x 14 $\frac{1}{4}$ W x 12 $\frac{1}{4}$ D. 43 lbs.\$149.95.

921

Air suspension. 12" woofer, 7" horn midrange, 3" upper midrange, 2" tweeter. CF: 2,000 Hz, 4,000 Hz, and 10,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 15; max., 40. Response: 30-20,000 Hz \pm 5 dB, ref. 104 dB/SPL at 18 inches. Fuse protection. 26H x 15 $\frac{1}{2}$ W x 12 $\frac{1}{4}$ D. 48 lbs.\$169.95.

CREATIVE SOUND

CS-6

Full-range system, dual-tone driver. Rated Z: 8. Response: 55-14,000 Hz. 83/7H x 15 $\frac{1}{2}$ W x 6 9/16D. 9 lbs.\$29.95.

CS-8-02

Acoustic suspension. 8" woofer, 3 $\frac{1}{2}$ " tweeter. CF: 2,500 Hz. Rated Z: 8. Power: min., 5; max., 20. Response: 35-20,000 Hz. 10 $\frac{1}{2}$ H x 17 $\frac{1}{2}$ W x 10 $\frac{1}{4}$ D. 18 $\frac{1}{2}$ lbs.\$59.95.

CS8-200

Acoustic suspension. 8" woofer, mylar dome tweeter. CF: 4,000 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 30-21,000 Hz. 10 $\frac{1}{2}$ H x 17 $\frac{1}{2}$ W x 10 $\frac{1}{4}$ D. 18 $\frac{1}{2}$ lbs.\$89.95.

CS-10-02

Acoustic suspension. 10" woofer, 3 $\frac{1}{2}$ " tweeter. CF: 2,500 Hz. Rated Z: 8. Power: min., 7 $\frac{1}{2}$; max., 25. Response: 30-20,000 Hz. 12 $\frac{1}{2}$ H x 21 $\frac{1}{2}$ W x 12D.\$79.95.

CS10-300

Acoustic suspension. 10" woofer, 5" midrange, mylar dome tweeter. CF: 1,250 Hz and 4,500 Hz. Rated Z: 8. Power: min., 7 $\frac{1}{2}$; max., 35. Response: 25-21,000 Hz. 12 $\frac{1}{2}$ H x 21 $\frac{1}{2}$ W x 12D. 32 lbs.\$139.95.

CS12-100

Acoustic suspension. 12" woofer, 5" mid-

range, 3 $\frac{1}{2}$ " tweeter. CF: 1,250 Hz and 4,000 Hz. Rated Z: 8. Power: min., 10; max., 30. Response: 30-20,000 Hz. 16H x 24W x 12D.\$99.95.

CS12-200

Bass reflex. 12" woofer, 5" midrange, mylar dome tweeter. CF: 1,250 Hz and 4,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 45. Response: 20-21,000 Hz. 27H x 16W x 10 $\frac{1}{4}$ D.\$169.95.

CS12-300

Bass reflex. 12" woofer, 5" (isolated) midrange, mylar dome tweeter. CF: 500 Hz and 4,500 Hz. Rated Z: 8. Power: min., 15; max., 60. Response: 20-21,000 Hz. Removable sculptured grille. 16H x 27W x 10 $\frac{1}{4}$ D. 40 lbs.\$229.95.

TSF-10

Bass reflex. 10" woofer, 5" (isolated) midrange, mylar dome tweeter. CF: 500 Hz and 4,500 Hz. Rated Z: 9. Power: min., 20; max., 65. Response: 18-21,000 Hz. Removable grille. 48H x 12W x 13 $\frac{1}{4}$ D. 56 lbs.\$299.95.

TSF-12

Bass reflex. 12" woofer, 5" (isolated) midrange, mylar dome tweeter. CF: 500 Hz and 4,500 Hz. Rated Z: 8. Power: min., 30; max., 85. Response: 16-21,000 Hz. Removable grille. 54H x 15 $\frac{1}{2}$ W x 13 $\frac{1}{2}$ D. 64 lbs.\$399.95.

CRISMAN

Mark II (Bookbinder series)

Modified bass reflex. 8" woofer, 3 $\frac{1}{2}$ " piezoelectric superhorn. CF: 3,500 Hz. Rated Z: 8. Power: min., 7; max., 45. Response: 55-22,000 Hz \pm 9 dB, ref. 77 dB/SPL. 21H x 12W x 12D. 27 lbs.\$89.

Mark IIb (Bookbinder series)

Modified bass reflex. 8" woofer, 4 $\frac{1}{2}$ " enclosed midrange, 3 $\frac{1}{2}$ " piezoelectric superhorn. CF: 800 Hz and 3,500 Hz. Controls: midrange and superhorn. Rated Z: 8. Power: min., 7; max., 45. Response: 55-22,000 Hz \pm 6 dB, ref. 74 dB/SPL. 21H x 12W x 12D. 30 lbs.\$109.

Mark IV (Glendinning series)

Modified bass reflex. 12" woofer, 3 $\frac{1}{2}$ " piezoelectric superhorn. CF: 3,500 Hz. Rated Z: 8. Power: min., 10; max., 70. Response: 45-22,000 Hz \pm 9 dB, ref. 77 dB/SPL. 29H x 15W x 15 $\frac{1}{2}$ D. 41 lbs.\$129.

Mark Vb (Glendinning series)

Modified bass reflex. 12" woofer, 4 $\frac{1}{2}$ " enclosed midrange, 3 $\frac{1}{2}$ " piezoelectric superhorn. CF: 800 Hz and 3,500 Hz. Controls: midrange and superhorn. Rated Z: 8. Power: min., 10; max., 70. Response: 45-22,000 Hz \pm 5 dB, ref. 73 dB/SPL. 29H x 15W x 15 $\frac{1}{2}$ D. 44 lbs.\$159.

Mark VIIb (Heffalump series)

Modified bass reflex. 15" woofer, two 5" enclosed midranges, 3 $\frac{1}{2}$ " piezoelectric superhorn. CF: 500 Hz and 3,500 Hz. Controls: midrange and superhorn. Rated Z: 8. Power: min., 15; max., 100. Response: 35-22,000 Hz \pm 6 dB, ref. 73 dB/SPL. 31H x 18W x 16D. 62 lbs.\$199.

CROWN

Aurallinear ES-212

Electrostatic top end, air suspension woofer. Two 10" dynamic woofers, twelve electrostatic panels. CF: 375 Hz. Controls: tweeter level, separate mode switch (normal biamp) circuit breaker for tweeter and woofer. Rated Z: 4. Power: min., 30; max., 80. Can be biamplified. 52H (stacked) x 21W x 16D. 100 lbs. \$595.

DAHLQUIST

Model DQ-6

Air suspension woofer; "diffractionless-mounted" midrange and tweeter. 12" woofer, midrange, tweeter. CF: 600 Hz and 3,500 Hz. Controls: treble. Rated Z: 8. Power: min., 25. Response: 40-18,500 Hz \pm 2 dB. 28 $\frac{3}{4}$ H x 14 $\frac{1}{4}$ W x 12D. 45 lbs.\$225.

Phased Array Model DQ-10

Air suspension woofer; "diffractionless" mounting of other drivers. 10" woofer, 5" midrange, 2" soft dome midrange, $\frac{3}{4}$ " pressure-loaded dome tweeter, piezoceramic super-tweeter. CF: 400 Hz, 1,000 Hz, 6,000 Hz, and 12,500 Hz. Controls: treble contour with boost or cut. Rated Z: 8. Power: min., 60; max., 200 (bass). Response: 40-25,000 Hz \pm 3 dB. 31 $\frac{1}{2}$ H x 30 $\frac{1}{2}$ W x 9D. 55 lbs.\$395.

DAYTON WRIGHT

XG-8 Mark 3

Full range electrostatic. Manufacturer states "Dipole with acoustic phase shift at rear at low frequencies." Ten full-range electrostatic panels 18" x 7", two 1" piezoceramic ultrasonic tweeters. CF: 16,500 Hz. Controls: ultrasonic tweeter level, bias voltage. Rated Z: 4. Power: min., 100; max., 500. Response: 32-24,000 Hz \pm 4 dB, ref. 94 dB at 1 meter. Panels: 39 $\frac{3}{8}$ H x 39 $\frac{3}{8}$ W x 9 $\frac{1}{2}$ D; supply unit: 10 $\frac{1}{2}$ H x 19W x 10D. Panels: 67 lbs.; supply unit: 97 lbs.\$2,385.

DESIGN ACOUSTICS

D-2

10" woofer, 1" (diameter) dome tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 20; max., 50. Response: 40-18,000 Hz \pm 3.5 dB. 35H x 12 $\frac{1}{2}$ W x 12 $\frac{1}{4}$ D. 35 lbs.\$150.

D-4

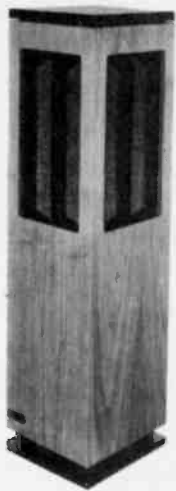
Column. 10" woofer, 5" midrange, three 2 $\frac{1}{2}$ " tweeters. CF: 800 Hz and 2,000 Hz. Controls: low- and high-frequency switches. Rated Z: 8. Power: min., 25; max., 75. Response: 40-16,000 Hz \pm 3 dB. Manufacturer claims wide dispersion. 38H x 17 $\frac{1}{2}$ W x 9 $\frac{1}{2}$ D. 60 lbs.\$199.

D-6

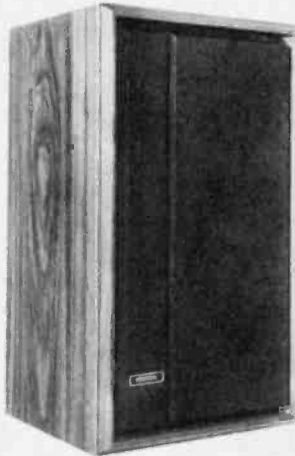
10" woofer, 5" midrange, five 2 $\frac{1}{2}$ " tweeters. CF: 800 Hz and 2,000 Hz. Controls: low- and high-frequency switches. Rated Z: 8. Power: min., 20; max., 100. Response: 35-16,000 Hz \pm 2 dB. Manufacturer claims wide dispersion. 24 $\frac{1}{2}$ H x 16 $\frac{1}{2}$ W x 13 $\frac{1}{4}$ D. 50 lbs.\$279.

D-12

10" woofer, 5" midrange, nine 2 $\frac{1}{2}$ " cone tweeters. CF: 700 Hz and 1,600 Hz. Controls:



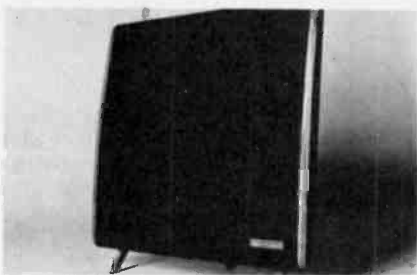
Creative Environments 89T



Creative Environments 881



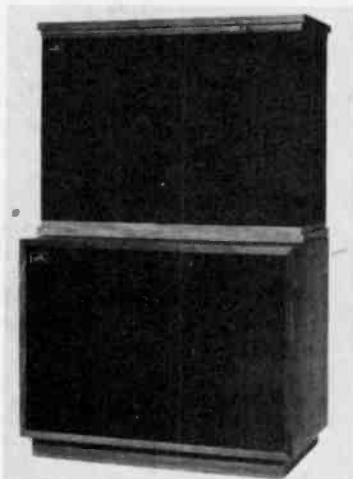
Crisman Mark IV



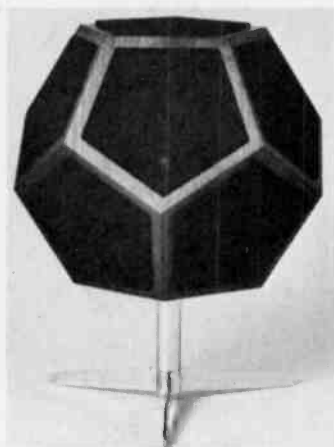
Dahlquist Model DQ-10



Dayton Wright XG-8



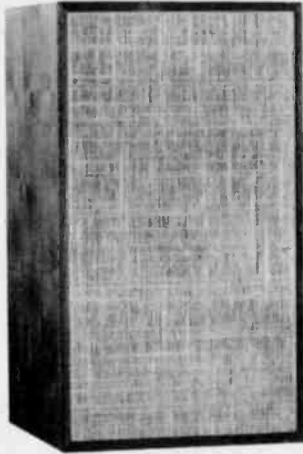
Crown Aurallnear ES-212



Design Acoustics D-12



Design Acoustics D-4



Dynaco A-25XL



D.W.D. AT-4



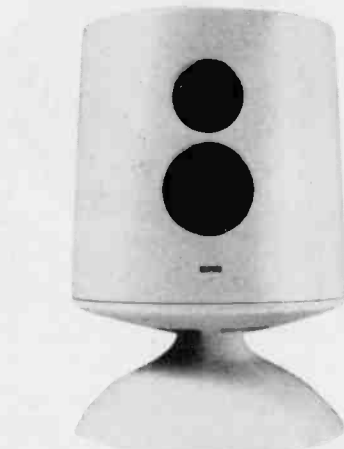
Eastman Sound
431 Crescendo



Electro Music Leslie
DVX Model 580



Electrostatic Research
139-2W



Empire 6000MIII

low and high frequency. Rated Z: 8. Power: min., 25; max., 100. Response: 30-15,000 Hz \pm 2 dB. Can be hung from ceiling. 30 inches high (with pedestal), 22" diameter. 50 lbs.\$399 (walnut bass); with chrome bass, \$425.

DUNTECH

DL-15/A

15" woofer, 5" midrange, two piezoelectric tweeters. CF: 350 Hz and 7,000 Hz. Rated Z: 8. Power: min., 30; max., 150. Response: 17-25,000 Hz \pm 3 dB. 5-yr. warranty. 32½H x 23½W x 18D.....\$449.

DYNACO

A-10VW

Vented "aperiodic." 6½" woofer, 1½" dome tweeter. CF: 2,500 Hz. Rated Z: 8. Power: min., 15; max., 50. 15H x 8½W x 8D. 15 lbs.\$110 per pair.

A-25

Vented "aperiodic." 10" woofer, 1½" dome tweeter. CF: 1,500 Hz. Controls: five-position tweeter level. Rated Z: 8. Power: min., 20; max., 60. 20H x 11½W x 10D. 24 lbs.\$92.50.

A-25XL

Vented "aperiodic." 10" woofer, 1" dome tweeter. CF: 1,200 Hz. Controls: 3-position tweeter level switch. Rated Z: 8. Power: min., 15. 20H x 11½W x 10D. 25 lbs.\$109.

A-35

Vented "aperiodic" dual-chamber. 10" woofer, 1½" dome tweeter. CF: 1,200 Hz. Controls: 5-position tweeter level switch. Rated Z: 8. Power: min., 20; max., 60. 22½H x 12½W x 10D. 30 lbs.\$129.

A-50

Vented "aperiodic" dual-chamber. Two 10" woofers, 1½" dome tweeter. CF: 1,000 Hz. Controls: 5-position tweeter level switch. Rated Z: 8. Power: min., 25; max., 100. 28H x 21½W x 10D. 47 lbs.\$189.

D.W.D.

AT-1

Acoustic suspension. 8" full range. Rated Z: 8. Power: min., 5; max., 35. Response: 50-15,000 Hz \pm 3dB, ref. 80 dB/SPL. Lifetime guarantee. 19H x 10½W x 9½D. 18 lbs.\$49.95.

AT-2

Acoustic suspension. 8" woofer, 3" tweeter. CF: 8,500 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 5; max., 40. Response: 50-17,000 Hz \pm 3 dB, ref. 83 dB/SPL. Removable grille; lifetime guarantee. 21¼H x 12W x 10½D. 23 lbs.\$84.95.

AT-3

Acoustic suspension. 10" woofer, 3" tweeter. CF: 8,500 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 5; max., 45. Response: 35-17,000 Hz \pm 3 dB, ref. 85 dB/SPL. Removable grille; lifetime guarantee; fuse protection. 22H x 13W x 12½D. 34 lbs.\$119.95.

AT-4

Acoustic suspension. 12" woofer, 5" mid-range, 3" tweeter. CF: 1,200 Hz and 8,400 Hz.

Controls: midrange level. Rated Z: 8. Power: min., 5; max., 50. Response: 30-17,000 Hz \pm 3 dB, ref. 87 dB/SPL. Removable grille; lifetime guarantee; fuse protection. 25 $\frac{1}{2}$ "H x 15W x 12 $\frac{1}{2}$ "D. 48 lbs.\$179.95.

AT-5

Acoustic suspension. Two 12" woofers, 5" midrange, 3" tweeter. CF: 1,100 Hz and 8,400 Hz. Controls: midrange level. Rated Z: 8. Power: min., 5; max., 110. Response: 25-17,000 Hz \pm 3 dB, ref. 90 dB/SPL. Removable grille; lifetime guarantee; fuse protection. 27H x 20 $\frac{1}{4}$ "W x 15 $\frac{1}{2}$ "D. 64 lbs.\$239.95.

EASTMAN SOUND

Martin Micro Max III

Infinite baffle. 8" woofer, 2 $\frac{1}{2}$ " phenolic ring tweeter. CF: 1,250 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 45. Response: 38-18,000 Hz, ref. 93 dB at 1 meter. 18H x 10 $\frac{1}{4}$ "W x 9 $\frac{3}{4}$ "D. 23 lbs.\$79.

231 Laboratory MK II

Infinite baffle. 10" woofer, 5" closed back midrange, compression horn tweeter. CF: 1,200 Hz and 4,400 Hz. Controls: separate mid and high frequency. Rated Z: 8. Power: min., 20; max., 50. Response: 34-18,000 Hz, ref. 91 dB at 1 meter. 21 $\frac{1}{2}$ "H x 12 $\frac{1}{2}$ "W x 10D. 30 lbs.\$139.

431 Crescendo

Infinite baffle. 12" woofer, 5" closed back midrange, two compression horn tweeters. CF: 750 Hz and 4,000 Hz. Controls: separate mid and high frequency. Rated Z: 8. Power: min., 25; max., 60. Response: 30-18,000 Hz, ref. 91 dB at 1 meter. 25 $\frac{1}{2}$ "H x 15W x 12D. 45 lbs.\$199.

471 Exorcist

Infinite baffle. 15" woofer, 5" close back midrange, two compression horn tweeters. CF: 750 Hz and 4,000 Hz. Controls: separate mid and high frequency. Rated Z: 8. Power: min., 30; max., 80. Response: 28-20,000 Hz, ref. 93 dB at 1 meter. 28H x 18W x 14D. 60 lbs.\$319.

831 Magnificat

Infinite baffle. Two 12" woofers, 5" closed back midrange, two compression horn tweeters. CF: 750 Hz and 4,000 Hz. Controls: separate mid and high frequency. Rated Z: 4. Power: min., 30; max., 80. Response: 28-20,000 Hz, ref. 94 dB at 1 meter. 37 $\frac{1}{2}$ "H x 18W x 14 $\frac{1}{4}$ "D. 90 lbs.\$349.

ELECTRO MUSIC

Leslie Plus 2 System Model 430

Ported bass reflex. 12" woofer, mid- and high-frequency horn. CF: 800 Hz. Controls: level for internal amplifiers; on/off switch; dispersion elements switch. Rated Z: 10. Sold only in pairs. 29 $\frac{3}{4}$ "H x 24 $\frac{1}{2}$ "W x 18 $\frac{1}{2}$ "D. 105 lbs. (main cabinet), 85 lbs. (satellite cabinet).\$347.50 (each).

Leslie Plus 2 System Model 470

Ported bass reflex. 15" woofer, two side-mounted midranges, dome tweeter. CF: 800 Hz and 4,000 Hz. Controls: on/off switch, mode switch, level. Rated Z: 10. Sold only in pairs. 33 $\frac{1}{4}$ "H x 30W x 20 $\frac{1}{2}$ "D. 118 lbs. (main cabinet), 98 lbs. (satellite cabinet).\$497.50.

Leslie DVX Series Model 570

Ducted port-woofer and dipole coupler. 15" woofer, 8" low midrange, 3" high midrange, two 1" dome tweeters. CF: 250 Hz, 1,500 Hz, and 5,000 Hz. Controls: crossover level switches. Rated Z: 4. Power: min., 15; max., 50. Response: 20-20,000 Hz, ref. 90 dB at 1 meter. 33 $\frac{1}{4}$ "H x 30W x 20 $\frac{1}{2}$ "D. 105 lbs.\$449.

Leslie DVX Series Model 580

Ducted port-woofer and dipole coupler. 15" woofer, 8" low midrange, 3" high midrange, two 1" dome tweeters. CF: 250 Hz, 1,500 Hz, and 5,000 Hz. Controls: crossover level switches. Rated Z: 4. Power: min., 15; max., 50. Response: 20-20,000 Hz, ref. 90 dB at 1 meter on axis. Optional casters \$16 per set. 33H x 29W x 20 $\frac{1}{2}$ "D (without casters). 98 lbs.\$473.

ELECTROSTATIC RESEARCH

11

Full-range electrostatic. Sixteen woofers, four tweeters. CF: 2,000 Hz. Rated Z: 8. Power: min., 25; max., 250. 6 ft. H x 3 ft. W x 6"D. 100 lbs.Price not available.

109

8" woofer, four electrostatic tweeters. CF: 1,800 Hz. Rated Z: 8. Power: min., 15; max., 65. Tweeters can be directed for dispersion. 11H x 19W x 10D. 18 lbs.\$109.90.

139-2W

10" woofer, eight electrostatic tweeters. CF: 2,000 Hz. Rated Z: 8. Power: min., 20; max., 100. Response: 32-32,000 Hz \pm 2 dB. System self energized; woofer radiates from rear. 28H x 16W x 16D. 48 lbs.\$159.90.

139-3W

10" down-facing woofer, 3" midrange, eight electrostatic tweeters. CF: 800 Hz and 3,200 Hz. Rated Z: 8. Power: min., 20; max., 100. Response: 32-32,000 Hz \pm 2 dB. 28H x 16W x 16D. 50 lbs.\$199.90.

159

10" woofer, four electrostatic tweeters. CF: 2,000 Hz. Rated Z: 8. Power: min., 20; max., 100. Response: 32-32,000 Hz \pm 2 dB. Tweeter can be directed for dispersion. 25H x 14W x 11 $\frac{1}{2}$ "D. 42 lbs.\$159.90.

ELECTRO-VOICE

EVS-13B

Acoustic suspension. 8" cone woofer, 2" cone tweeter. CF: 1,500 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 25. Response: 50-18,000 Hz \pm 5 dB. 10H x 19W x 8 $\frac{1}{4}$ "D. 19 lbs.\$69.95.

A Note on Prices

Prices shown in these pages are manufacturers' or importers' suggested retail prices, updated as is feasible by press time. They may be subject to variation in different locales and to discounts among different retailers. However, most established audio dealers advise that the less discount offered, the more the buyer can expect in the way of consultation, advice, and service.

EVS-14B

Acoustic suspension. 10" cone woofer, 2" cone tweeter. CF: 1,500 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 25. Response: 40-18,000 Hz \pm 5 dB. 13 $\frac{1}{2}$ "H x 24W x 11 $\frac{1}{4}$ "D. 28 lbs.\$109.95.

EVS-15B

Acoustic suspension. 10" cone woofer, 5" cone midrange, 2" cone tweeter. CF: 700 Hz and 3,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 25. Response: 40-20,000 Hz \pm 5 dB. 13 $\frac{1}{2}$ "H x 24W x 11 $\frac{1}{4}$ "D. 39 lbs.\$139.95.

EVS-16B

Acoustic suspension. 12" cone woofer, 5" cone midrange, 2" cone tweeter. CF: 700 Hz and 3,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 25. Response: 30-20,000 Hz \pm 5 dB. 14H x 25W x 13 $\frac{1}{2}$ "D. 45 lbs.\$159.95.

Interface A

Vented. 12" cone vent substitute, 8" cone woofer, two 2" cone tweeters. CF: 55 Hz and 1,500 Hz. Controls: tweeter (on equalizer). Rated Z: 8. Power: min., 10; max., 25. Response: 32-20,000 Hz \pm 3 dB. 22H x 14W x 7 $\frac{1}{4}$ "D. 35 lbs.\$450 per pair.

Interface B

Vented. 10" cone vent substitute, 8" cone woofer, 2" cone tweeter. CF: 55 Hz and 1,500 Hz. Controls: tweeter (on equalizer). Rated Z: 8. Power: min., 5; max., 25. Response: 36-18,000 Hz \pm 3 dB. 23H x 14W x 9 $\frac{1}{4}$ "D. 27 lbs.\$325 per pair.

Musicaster IA

Bass Reflex. 12" coaxial cone driver. CF: 4,000 Hz. Rated Z: 8. Power: min., 5; max., 20. Response: 80-10,000 Hz. Outdoor, weatherproof speaker; Musicaster IIA with tweeter extends response to 16,000 Hz at \$138. 21 $\frac{1}{2}$ "H x 21 $\frac{1}{2}$ "W x 8 $\frac{1}{2}$ "D. 29 lbs.\$109.50.

Sentry III

Vented. 15" cone woofer, 8 $\frac{1}{2}$ " x 32" sectoral horn midrange, 4" x 6" sectoral horn tweeter. CF: 600 Hz and 3,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 5; max., 50. Response: 40-18,000 Hz \pm 3 dB. Optional SEQ equalizer at \$60 extends low-end response to 28 Hz. 28 $\frac{1}{2}$ "H x 34 $\frac{1}{2}$ "W x 20 $\frac{1}{2}$ "D. 156 lbs.\$650.

EMPIRE

6000MIII

12" woofer, midrange, ultrasonic tweeter. Controls: bass and treble. Rated Z: 8. Power: max., 100. Response: 30-20,000 Hz. Choice of imported marble or walnut finish top. 24 $\frac{1}{2}$ " inches high, 18 inches in diameter.\$149.95.

6500II

12" woofer, midrange, ultrasonic tweeter. Rated Z: 8. Power: max., 110. Response: 30-20,000 Hz. Choice of four colors. 25 $\frac{1}{2}$ "H x 17 $\frac{1}{4}$ "W. \$159.95 in white, \$169.95 in decorator colors.

7500MII

15" woofer, dome midrange, ultrasonic dome tweeter. Controls: 3-position treble switch. Rated Z: 8. Power: max., 125. Response: 25-20,000 Hz. Choice of imported marble or

walnut finish top. 26¼ inches high, 20 inches in diameter. \$249.95.

9000GT

15" woofer, domed midrange, ultrasonic dome tweeter. Rated Z: 8. Power: max., 150. Response: 15-25,000 Hz. Choice of smoked glass or walnut veneer top. 30 inches high, 18 inches in diameter. \$329.95.

EPIPURE

10

Acoustic suspension. 8" woofer, 1" "air spring" tweeter. CF: 1,800 Hz. Controls: tweeter rheostat. Rated Z: 8. Power: min., 12; max., 50. Response: 45-20,000 Hz ± 3 dB. 9H x 11W x 21D. 25 lbs. Price not available.

11

Tuned port. 6" woofer, 1" tweeter. CF: 1,800 Hz. Controls: 3-position tweeter switch. Rated Z: 8. Power: min., 25; max., 100. Response: 38-20,000 Hz ± 3 dB. 20H x 12W x 10D. 30 lbs. Price not available.

M-20

Acoustic suspension. Two 8" woofers, two 1" "air spring" tweeters. CF: 1,800 Hz. Controls: Tweeter rheostat. Rated Z: 4. Power: min., 25; max., 125. Response: 40-20,000 Hz ± 3 dB. 27¾H x 11W x 18½D. 50 lbs. Price not available.

50

Acoustic suspension. 6" woofer, 1" tweeter. CF: 1,800 Hz. Rated Z: 4. Power: min., 20; max., 80. Response: 50-20,000 Hz ± 3 dB. 13H x 10W x 8D. 15 lbs. Price not available.

EPI 60

Acoustic suspension. 6" woofer, 1" "air spring" tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 10; max., 35. Response: 50-18,000 Hz ± 3dB. 17H x 9W x 7D. 15 lbs. Price not available.

EPI 90

Acoustic suspension. 8" woofer, 1" "air spring" tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 12; max., 50. Response: 45-18,000 Hz ± 3 dB. 21H x 11W x 9D. 25 lbs. Price not available.

100

Acoustic suspension. 8" woofer, 1" "air spring" tweeter. CF: 1,800 Hz. Controls: Rheostat. Rated Z: 8. Power: min., 12; max., 50. Response: 45-18,000 Hz ± 3 dB. 9H x 11W x 21D. 25 lbs. Price not available.

EPI 110

Acoustic suspension. 8" woofer, 1" "air spring" tweeter. CF: 1,800 Hz. Controls: tweeter rheostat. Rated Z: 8. Power: min., 15; max., 60. Response: 35-18,000 Hz ± 3 dB. 24H x 14W x 10D. 30 lbs. Price not available.

150 The Monitor

Acoustic suspension. 8" woofer, 1" "air spring" tweeter. CF: 1,800 Hz. Controls: tweeter rheostat. Rated Z: 8. Power: min., 10; max., 85. Response: 33-19,000 Hz ± 3 dB. 11H x 15W x 25D. 30 lbs. Price not available.

EPI 180

Acoustic suspension. Two 8" woofers, two 1"

tweeters. CF: 1,800 Hz. Controls: tweeters rheostat. Rated Z: 4. Power: min., 25; max., 100. Response: 43-18,000 Hz. 15¼H x 24½W x 12D. Price not available.

EPI 250

Acoustic suspension. Two 8" woofers, two 1" "air spring" tweeters. CF: 1,800 Hz. Controls: tweeters rheostat. Rated Z: 4. Power: min., 20; max., 100. Response: 35-18,000 Hz ± 3 dB. 15H x 15W x 25D. 40 lbs. Price not available.

400+ The Minitower

Acoustic suspension. Four 6" woofers, four 1" "air spring" tweeters. CF: 1,800 Hz. Controls: 3-position toggle switch. Power: min., 25; max., 200. Response: 27-19,000 Hz ± 3 dB. Manufacturer claims quadripolar or omnidirectional radiation. 14H x 14W x 38D. 90 lbs. Price not available.

1000 The Tower

Acoustic suspension. Four 8" woofers, four 1" "air spring" tweeters. CF: 1,800 Hz. Rated Z: 8. Power: min., 60; max., 250. Response: 22-20,000 Hz ± 3 dB. Manufacturer claims quadripolar or omnidirectional radiation. 75H x 18W x 18D. 180 lbs. \$1,000.

MT I Microtower

Organ pipe principal. Two 4½" full range. Rated Z: 8. Power: min., 5; max., 60. 32H x 8½W x 8½D. 21 lbs. Price not available.

MT2 Microtower

Organ pipe principal. Two 4½" full range, two 1" "air spring" tweeters. CF: 3,000 Hz. Rated Z: 8. Power: min., 15; max., 70. 34H x 8½W x 8½D. 28 lbs. Price not available.

MT3 Microtower

Organ pipe loading principle. Four 4½" full range, two 1" "air spring" tweeters. CF: 3,000 Hz. Rated Z: 8. Power: min., 25; max., 100. 36H x 11½W x 11½D. 55 lbs. Price not available.

MTB I Microtower Bookshelf

Bass reflex. 4½" full range. Rated Z: 8. Power: min., 10; max., 60. Response: 60-16,000 Hz ± 5 dB. 10½H x 15W x 17½D. 10 lbs. Price not available.

MTB II Microtower Bookshelf

Organ pipe principal. Two 4½" full range, 1" "air spring" tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 20; max., 80. Response: 55-18,000 Hz ± 3 dB. 22¼H x 9½W x 13D. 23 lbs. Price not available.

EQUASOUND

Model I

Air suspension. 12" woofer, 4" midrange, 1" dome tweeter. CF: 400 Hz and 2,400 Hz. Controls: tweeter. Rated Z: 8. Power: min., 25; max., 100. Response: 35-20,000 Hz. Internally equalized crossover network. 32H x 16W x 12D. 55 lbs. \$225.

Model II

Transmission line. 12" woofer, 4" midrange, three 1" dome tweeters. CF: 400 Hz and 2,400 Hz. Controls: tweeter. Rated Z: 8. Power: min., 25; max., 100. Response: 30-20,000 Hz. Patented enclosure design, internally equal-

ized crossover network. 42H x 14½W x 14½D. 70 lbs. \$350.

ESS

AMT 1

Resistive port. 10" woofer, Heil air-motion transformer midrange tweeter. CF: 700 Hz. Controls: 3-position brightness switch. Rated Z: 4. Power: min., 20; max., 350. Response: 45-24,000 Hz ± 2.5 dB. Fuse protection. 31H x 14¼W x 14¼D. \$349.

AMT 1 Tower

Transmission line labyrinth. 10" high excursion woofer. Heil air-motion transformer midrange tweeter. CF: 700 Hz. Controls: 3-position brightness switch. Rated Z: 4. Power: min., 20; max., 400. Response: 35-24,000 Hz ± 2.5 dB. Fuse protection. 43½H x 14¾W x 17½D. 120 lbs. \$399.

AMT 3 Rock Monitor

Damped infinite baffle. Two high acceleration 10" woofers, 6" transition driver. Heil air-motion transformer midrange tweeter. CF: 250 Hz and 700 Hz. Controls: 3-position brightness switch. Rated Z: 4. Power: min., 20; max., 500. Response: 40-24,000 Hz ± 2 dB. Fuse protection. 39¼H x 15¾W x 15¾D. 115 lbs. \$469.

AMT 4

Acoustic suspension. 10" woofer. Heil air-motion transformer midrange tweeter. CF: 1,000 Hz. Controls: 3-position brightness switch. Rated Z: Power: min., 20; max., 250. Response: 45-24,000 Hz ± dB. Fuse protection. 27H x 15¾W x 12½D. 70 lbs. \$269.

AMT 5

Acoustic suspension. 12" woofer, 3" Heil air-motion transformer tweeter. CF: 1,500 Hz. Controls: 3-position brightness switch. Rated Z: 4. Power: min., 15; max., 150. Response: 45-24,000 Hz ± 3.5 dB. Fuse protection. 24H x 14½W x 12¾D. Walnut 44 lbs.; vinyl 37 lbs. Walnut, \$189; Vinyl, \$169.

AMT 6 Professional

Damped infinite baffle. Two 12" woofers, four dual magnetic plate transformers. CF: 800 Hz. Controls: 3-position brightness switch integral with passive crossover. Rated Z: 6. Power: min., 50; max., 1,000. Response: 35-24,000 Hz ± 3 dB. Fuse protection. 47¾H x 24½W x 18½D. 215 lbs. \$695.

FAIRFAX

F-2A

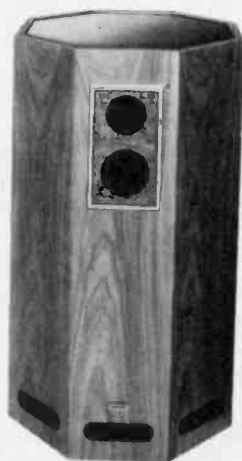
Ported. 8" woofer, 3½" tweeter. CF: 5,500 Hz. Rated Z: 8. Power: min., 7; max., 25. Response: 40-20,000 Hz. 18H x 12W x 9D. 25 lbs. \$89.95.

FTA-2

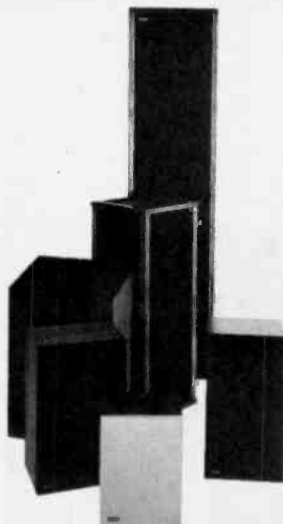
Acoustic suspension. 8" woofer, 5" midrange, 3½" tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 10; max., 50. Response: 30-20,000 Hz. 24H x 14W x 12D. 45 lbs. \$169.95.

FX-100B

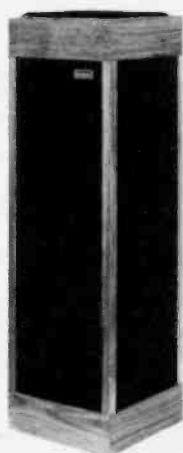
Tuned port. 8" woofer, 3½" tweeter. CF:



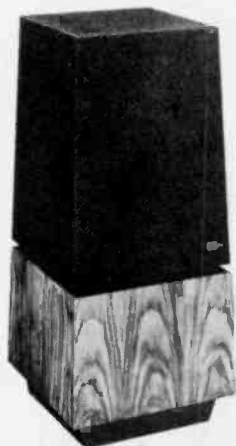
Empire 9000GT



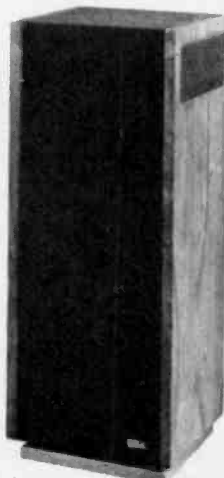
Epicure Various Models



Equasound Model II



ESS AMT 1



ESS AMT 3

2,000 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 7; max., 30. Response: 38-20,000 Hz. 22H x 12W x 10D. 30 lbs.\$109.95.

FX-300

Ducted port. 10" woofer, 3 1/2" tweeter. CF: 2,000 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 7; max., 50. Response: 34-20,000 Hz. 22H x 14W x 10 1/4D. 42 lbs.\$129.95.

FX-350

10" woofer, 5" midrange, 3 1/2" tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 10; max., 60. Response: 24-20,000 Hz. 36H x 14W x 12D. 70 lbs.\$199.95.

FX-400

Ducted port. 10" woofer, 5" midrange, 3 1/2" tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 8; max., 80. Response: 20-20,000 Hz. 28H x 14W x 28D. 105 lbs.\$289.95.

Wall of Sound

"Integrated Cyclone." Six 8" woofers, two 5" midranges, two 3 1/2" tweeters, two dome super-tweeters. CF: 80 Hz, 2,000 Hz, 5,000 Hz, and 9,000 Hz. Rated Z: 6.5. Power: min., 20; max., 100. Response: 20-20,000 Hz. 52H x 30W x 6 1/2D. 125 lbs.\$429.95.

FISHER

XP-48

Infinite baffle. 6" woofer, 2 1/2" tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 4; max., 8. Response: 50-18,000 Hz. 18 3/4H x 11 1/4W x 7 1/2D. 11 lbs.\$49.95.

XP-57

Acoustic suspension. 8" woofer, 2 1/2" tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 5; max., 18. Response: 38-18,000 Hz. Removable cloth grille. 21H x 12 1/4W x 9D. 20 lbs.\$79.95.

XP-62

Acoustic suspension. 10" woofer, 3" tweeter. CF: 2,500 Hz. Rated Z: 8. Power: min., 5; max., 25. Response: 35-20,000 Hz. Removable cloth grille. 22 3/4H x 12 1/4W x 10D. 25 lbs.\$99.95.

XP-68

Acoustic suspension. 10" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 5,000 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 35-20,000 Hz. Removable cloth grille. 22 3/4H x 12 3/4W x 10D. 27 lbs.\$129.95.

XP-75

Acoustic suspension. 12" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 5,000 Hz. Rated Z: 8. Power: min., 8; max., 45. Response: 32-20,000 Hz. Removable grille cloth. 25 1/4H x 14 1/4W x 12D. 34 lbs.\$169.95.

XP-85

Acoustic suspension. 12" woofer, two 5" midranges, 3" flare dome tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: separate midrange and tweeter. Rated Z: 8. Power: min., 8; max., 50. Response 32-20,000 Hz. Removable grille cloth. 25 1/4H x 14 1/4W x 12D. 41 lbs.\$199.95.

XP-95

Acoustic suspension. 15" woofer, two 5" mid-ranges, 3" flare dome tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: separate midrange and tweeter. Rated Z: 8. Power: min., 8; max., 60. Response: 28-20,000 Hz. Removable grille cloth. 28H x 17½W x 12½D. 51 lbs.\$249.95.

ST 420

Acoustic suspension. 8" woofer, 3" flare dome tweeter. CF: 2,500 Hz. Controls: tweeter. Rated Z: 6-8. Power: min., 12; max., 75. Response: 49-20,000 Hz ± 4 dB. Removable foam grille. 21H x 12¼W x 9D. 22 lbs.Price not available.

ST 430

Acoustic suspension. 10" woofer, 3" flare dome tweeter. CF: 2,500 Hz. Controls: tweeter. Rated Z: 6-8. Power: min., 12; max., 100. Response: 47-20,000 Hz ± 4 dB. Removable foam grille. 22¾H x 12¼W x 10D. 25 lbs.Price not available.

ST 450

Acoustic suspension. 10" woofer, 6" flare dome midrange, 3" flare dome tweeter. CF: 600 Hz and 5,000 Hz. Controls: tweeter. Rated Z: 6-8. Power: min., 15; max., 125. Response: 45-20,000 Hz ± 4 dB. Removable foam grille. 25¼H x 14¾W x 12D. 40 lbs.Price not available.

ST 470

Acoustic suspension. 12" woofer, 6" flare dome midrange, 3" flare dome tweeter. CF: 600 Hz and 5,000 Hz. Controls: separate midrange and tweeter. Rated Z: 6-8. Power: min., 20; max., 200. Response: 41-20,000 Hz ± 4 dB. Removable foam grille. 25¼H x 14¾W x 12D. 42 lbs.Price not available.

FRAZIER

F4-4 Super Midget

Modified Helmholtz resonator, tuned slit. 4" full range. Rated Z: 8. Power: min., 2; max., 10. 15¾H x 7¼W x 9½D. 13½ lbs.under \$50.

F8-4SH-A Super Monte Carlo-A

Modified Helmholtz resonator, tuned slit. 8" heavy duty woofer, piezoelectric super-horn tweeter. Rated Z: 8. Power: min. 3.5; max., 20. 19H x 10¼W x 11½D. 30 lbs.under \$100.

F10-HZ Mark IV-A

Modified Helmholtz resonator, tuned slit. 10" woofer, 3" x 7" compression horn tweeter. CF: 2,000 Hz. Controls: variable high frequency. Rated Z: 8. Power: min., ½; max., 30. Removable grille; choice of color; bookshelf or floor-standing system. 14H x 24W x 12D. 43 lbs.under \$160.

F10W-37H-A Concerto

Modified Helmholtz resonator, tuned slit. 10" woofer, 3" x 7" compression horn, piezoelectric super-horn tweeter. CF: 2,000 Hz. Controls: high frequency. Rated Z: 8. Power: min. ½; max., 30. Removable grille; choice of color. 21½H x 16W x 16D. 47 lbs.under \$225.

F12-2-H Seven

Modified Helmholtz resonator, tuned slit. 12" woofer, two 4" midranges (isolated in separate box within enclosure), two 3" x 7" compression horn tweeters. CF: 500 Hz and 3,000 Hz. Controls: variable high frequency and mid-



Frazier F4-4



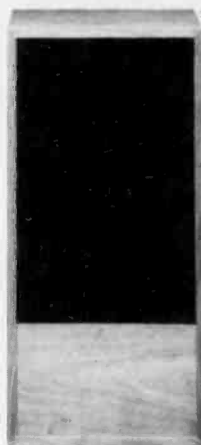
Frazier F12-8-WHA



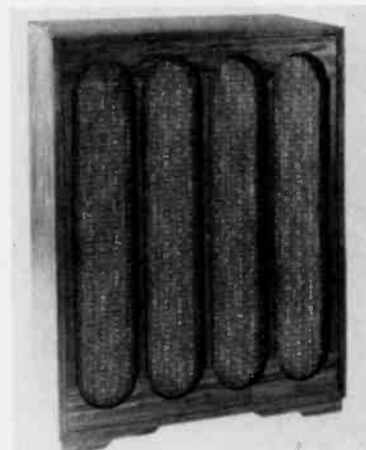
Frazier F10W-37H-A



Grafyx SP-8



Hartley Zodiac '75



Hartley Concertmaster VI

range. Rated Z: 8. Power: min., 1/2; max., 30. Removable foam grille; choice of colors; two-piece base allows horizontal or vertical placement. 29H x 19W x 16D. 101 lbs. ...under \$350.

F12-2-5T Mark V

Modified Helmholtz resonator, tuned slit. 12" woofer, two 4" midrange (isolated in separate box within enclosure), 3" x 7" compression horn tweeter. CF: 800 Hz and 3,000 Hz. Controls: variable high frequency and midrange. Rated Z: 8. Power: min., 1/2; max., 30. Removable foam grille; choice of color; tuning slit reflects from rear. 25 1/4H x 14W x 12D. 56 lbs.under \$260.

F12-8-WHA Mark VI-A

Modified Helmholtz resonator, tuned slit. 12" woofer, 8" midrange (isolated in separate cabinet within enclosure), 3" x 7" compression horn tweeter, piezoelectric super-horn tweeter. CF: 600 Hz and 3,000 Hz. Controls: variable high frequency and midrange. Rated Z: 8. Power: min: 2.5; max., 30. Tuning slit reflects from rear. 25 1/4H x 29W x 16 1/2D. 111 lbs.under \$450.

GRAFYX

SP-6

Transmission line. 6" woofer, piezoelectric tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 10; max., 30. Response: 15-20,000 Hz ± 5 dB. 5-yr. warranty, removable grille. 19H x 11W x 9D. 20 lbs.\$79.

SP-8

Transmission line. 8" woofer, phenolic ring tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 15; max., 75. Response: 40-20,000 Hz ± 5 dB. 5-yr. warranty, removable grille. 24H x 13 1/2W x 10 1/2D. 35 lbs.\$99.

SP-10

Transmission line. 10" woofer, Philips hard dome tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 15; max., 100. Response: 31-20,000 Hz ± 5 dB. 27H x 15 1/2W x 13D. 45 lbs.\$129.

HARTLEY

Concertmaster Jr.

Magnetic suspension. 10" full range, 1" dome tweeter. CF: 2,000 Hz and 5,000 Hz. Rated Z: 5-8. Power: min., 15; max., 75. Response: 20-25,000 Hz ± 3 dB. 30H x 24W x 14D. 85 lbs.\$350.

Concertmaster III

Magnetic suspension. 18" woofer, 10" midrange, 7" tweeter, 1" super-tweeter. CF: 200 Hz, 3,000 Hz, and 7,000 Hz. Rated Z: 6-8. Power: min., 25; max., 125. Response:

16-25,000 Hz ± 3 dB. 34H x 29W x 16D. 125 lbs.\$885.

Concertmaster IV

Magnetic suspension. 18" woofer, 10" midrange, 7" tweeter, 1" super-tweeter. CF: 200 Hz, 3,000 Hz, and 7,000 Hz. Rated Z: 6-8. Power: min., 25; max., 125. Response: 16-25,000 Hz ± 3 dB. 34H x 29W x 16D. 125 lbs.\$910.

Concertmaster V

Magnetic suspension. 24" woofer, 10" midrange, 7" tweeter, 1" super-tweeter. CF: 200 Hz, 3,000 Hz, and 7,000 Hz. Rated Z: 6-8. Power: min.; 25; max., 125. Response: 16-25,000 Hz ± 3 dB. 40 1/2H x 29W x 18D. 150 lbs.\$940.

Concertmaster VI

Magnetic suspension. 24" woofer, 10" midrange, 7" tweeter, 1" super-tweeter. CF: 200 Hz, 3,000 Hz, 7,000 Hz. Rated Z: 6-8. Power: min., 25; max., 125. Response: 16-25,000 Hz ± 3 dB. 40 1/2H x 29W x 18D. 150 lbs.\$965.

Holton A

Magnetic suspension. 10" full range, 1" dome tweeter. CF: 2,000 Hz and 5,000 Hz. Rated Z: 5-8. Power: min., 15; max., 75. Response: 20-25,000 Hz ± 3 dB. 30H x 24W x 14D. 85 lbs.\$335.

Holton Jr.

Magnetic suspension. 10" full range, 1" dome tweeter. CF: 2,000 Hz and 5,000 Hz. Rated Z: 5-8. Power: min., 15; max., 75. Response: 25-25,000 Hz ± 3 dB. 30H x 15W x 12D. 55 lbs.\$285.

Zodiac I

Mechanical suspension. 10" woofer/midrange, 1" dome tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 10; max., 50. Response: 40-25,000 Hz ± 4 dB. Reversible grille, asymmetrical matched pairs. 21 1/4H x 14 1/2W x 8 3/4D. 30 lbs.\$97.

Zodiac '75

Mechanical suspension. 10" woofer/midrange, 1" dome tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 10; max., 50. Response: 35-25,000 Hz ± 4 dB. Reversible grille, asymmetrical matched pairs. 30H x 15W x 12D. 50 lbs.\$136.

Zodiac 300

Mechanical suspension. Two 10" woofer/midrange, 1" dome tweeter. CF: 2,000 Hz. Rated Z: 4. Power: min., 10; max., 60. Response: 30-25,000 Hz ± 4 dB. Full kickbase included. 25 1/2H x 23 1/2W x 11 1/2D. 65 lbs. \$225.

HEATH

AS-48

Reflex. 14" woofer, 2" tweeter. CF: 2,000 Hz. Controls: 3-position high-frequency switch. Rated Z: 8. Power: max., 50. Response: 40-20,000 Hz. Kit; oak veneer finish; JBL drivers. 14H x 23 1/2W x 12D. 57 lbs.\$249.95.

AS-101

Bass reflex. 15" woofer, sectoral horn tweeter/midrange. CF: 800 Hz. Controls: high frequency. Rated Z: 8. Power: min., 5; max., 50. Response: 35-20,000 Hz. Kit form; pecan veneer finish; Altec-Lansing drivers. 29 1/2H x

27 1/4W x 19 1/2D. 128 lbs.\$329.95.

AS-103A

Acoustic suspension. 12" woofer, hemispherical dome midrange and tweeter. CF: 575 Hz and 5,000 Hz. Controls: variable midrange and tweeter. Rated Z: 4. Power: min., 25; max., 100. Response: 20-20,000 Hz. Kit; walnut veneer finish; Acoustic Research drivers. 25H x 14W x 11 1/4D. 64 lbs.\$199.95.

AS-104

Acoustic suspension. 10" woofer, 4 1/2" midrange, 3 1/2" cone dome tweeter. CF: 500 Hz and 4,500 Hz. Controls: midrange and high frequency. Rated Z: 8. Power: min. 10; max., 100. Response: 30-18,000 Hz. Kit; 24H x 13 1/2W x 11 1/2D. 54 lbs.\$109.95.

AS-105U/W

Acoustic suspension. 10" woofer, 3 1/2" cone/dome tweeter. CF: 1,000 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 100. Response: 30-18,000 Hz. Kit; unfinished or walnut veneer. 24H x 13 1/2W x 11 1/2D. 52 lbs.unfinished \$79.95; walnut veneer \$89.95.

AS-106

Infinite baffle. 4 1/2" full range. Rated Z: 8. Power: min., 4; max., 20. Response: 70-16,000 Hz ± 5 dB. Kit; 12H x 7W x 6D. 10 lbs. \$24.95.

AS-1039

Bass reflex. 8" woofer, exponential horn tweeter. CF: 3,500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 5; max., 25. Response: 70-15,000 Hz. Kit; 21 1/2H x 12W x 10 1/2D. 36 lbs.\$54.95.

AS-1042

Infinite baffle. 8" woofer, 3 1/2" cone/dome tweeter. CF: 1,500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 50. Response: 40-18,000 Hz. Kit; 19H x 10W x 8 1/4D. 27 lbs.\$44.95.

HED SYSTEMS

V-8

Infinite baffle. 8" woofer, 1" dome tweeter. CF: 2,800 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 45-20,000 Hz ± 3 1/2 dB. ref. 92 dB/SPL at 1 meter. Foam grille may be spray-painted to match room décor. 21H x 11W x 10D. 20 lbs.\$79.50.

V-10

Ducted reflex. 10" woofer, 1" dome tweeter. CF: 2,500 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 5; max., 40. Response: 40-20,000 Hz ± 3 dB. ref. 94 dB/SPL at 1 meter. Foam grille may be spray-painted to match décor. 25H x 14W x 10D. 35 lbs. \$99.50.

V-12

Ducted reflex. 12" woofer, 1" dome tweeter. CF: 2,300 Hz. Controls: tweeter level. Rated Z: 9. Power: min., 5; max., 45. Response: 38-20,000 ± 3 dB. ref. 95 dB/SPL at 1 meter on axis. Foam grille may be spray-painted. 25H x 14 1/2W x 12D. 40 lbs.\$119.50.

HEGEMAN

H-1A

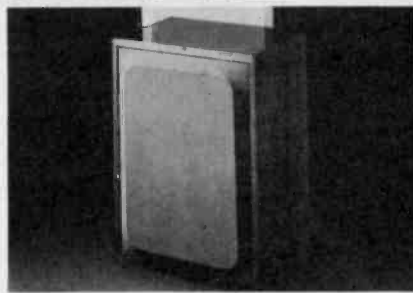
Floor-standing closed box baffle. 8" full range

How Should A Speaker Sound?

The extent to which a speaker produces no sound other than that which it is "ordered" to produce by the amplifier signal is a practical measure of its fidelity or accuracy. This quality is, to some extent, indicated by technical data but the ultimately true test is to listen to the speaker used in a sound playback system.



Heath AS-101



JBL L65 Jubal



Hegeman H-1A and HSW



IMF Model R

cone, 1" dome super-tweeter. CF: 5,000 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 20; max., 25. Response: 30-20,000 Hz \pm 2.5dB. 26H x 11W x 8 $\frac{3}{4}$ D. 25lbs.vinyl, \$159; walnut, \$189.

H-2
Floor-standing closed box baffle. 10" full range cone, 2" skirted dome super-tweeter. CF: 3,500 Hz. Controls: tweeter level. Rated Z: 8. Power: min., 30; max., 30. Response: 25-25,000 Hz. \pm 2 dB. 34H x 14W x 12D. 42 lbs.\$378.

HSW
Floor-standing closed box baffle. 15" aluminum high-compliance full range. CF: 50-100 Hz (external). Rated Z: 8. Power: min., 60; max., 120. Response: 8-200 Hz. Designed for 50-50 mix through external amplifier for low-frequency enhancement. 40H x 18W x 16D. 60 lbs.\$600.

IMF

Model R
Resistive line tunnel. 12" x 8" flat piston woofer, 6" cone midrange, $\frac{3}{4}$ " dome tweeter. CF: 375 Hz and 3,500 Hz. Controls: 3-position impulse. Rated Z: 8. Power: min., 25. Response: 25-30,000 Hz. Accessory stands available, supplied in matched mirror image pairs. 28H x 16W x 14 $\frac{1}{4}$ D. 65 lbs.\$330.

Monitor Mark III Improved
Transmission line. 13" x 9 $\frac{1}{2}$ " flat piston woofer, 6" cone midrange, $\frac{1}{4}$ " dome tweeter, $\frac{3}{4}$ " dome super-tweeter. CF: 375 Hz, 3,500 Hz, and 13,000 Hz. Controls: separate mid-

range and tweeter level. Rated Z: 8. Power: min., 25. 42H x 17 $\frac{1}{2}$ W x 19 $\frac{3}{4}$ D. 140 lbs..\$1,000.

Smaller Monitor
Transmission line. 11 $\frac{1}{4}$ " x 8 $\frac{1}{4}$ " flat piston woofer, 6" cone midrange, $\frac{1}{4}$ " dome tweeter, $\frac{3}{4}$ " dome super-tweeter. CF: 375 Hz, 3,500 Hz, and 13,000 Hz. Controls: 3-position "perspective." Rated Z: 8. Power: min., 25. 38 $\frac{1}{2}$ H x 16W x 18D. 130 lbs.\$750.

Studio IIIB
Transmission line. 8" cone woofer, 5" cone midrange, $\frac{1}{8}$ " dome tweeter, $\frac{3}{4}$ " dome super-tweeter. CF: 375 Hz, 3,500 Hz, and 13,000 Hz. Controls: 3-position "perspective." Rated Z: 8. Power: min., 25. 36H x 14W x 15D. 70 lbs.\$450.

Super Compact
Line tunnel. 8" cone woofer, 5" cone midrange, $\frac{1}{8}$ " dome tweeter. CF: 375 Hz, 3,000 Hz. Rated Z: 8. Power: min., 25. 18H x 11W x 11 $\frac{1}{4}$ D. 20lbs.\$210.

INFINITY

1001A
Transmission line. 12" treated woofer, two 2" tweeters. CF: 1,300 Hz. Controls: tweeter. Rated Z: 8. Power: min., 20; max., 125. Response: 33-21,000 Hz \pm 4.5 dB. Transient and ambient tweeter array. 25H x 14 $\frac{1}{2}$ W x 12D. 44 lbs.\$139.

2000 II
Transmission line. 12" treated woofer, 4" midrange, 1" mid-tweeter, Walsh tweeter. CF: 800 Hz, 4,000 Hz, and 10,000 Hz. Controls: mid-

range and tweeter. Rated Z: 8. Power: min., 20; max., 250 (fused). Response: 28-28,000 Hz. Floor-standing; hard or soft top. 22 $\frac{1}{4}$ H x 36 $\frac{1}{2}$ W x 17D. 74 lbs.\$329.

POS II
Bass reflex. 10" woofer, 2" tweeter. CF: 1,600 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 100. Response: 43-19,000 Hz \pm 3.5 dB. 25H x 13W x 11 $\frac{1}{4}$ D. 38 lbs.\$98.

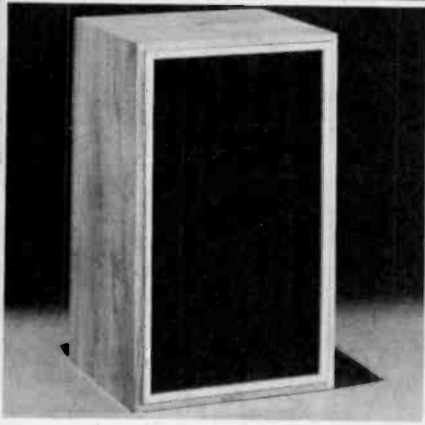
Monitor II
Transmission line. 12" patented woofer, $\frac{1}{2}$ " dome midrange, 1" dome tweeter. Walsh tweeter. CF: 450 Hz, 5,000 Hz, and 10,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 45; max., 250 (fused). Response: 26-28,000 Hz \pm 4 dB. 17H x 50W x 16D. 94 lbs.\$449.

Servo Static IA
Electrostatic mid and high, dynamic woofer. 18" woofer. CF: 70 Hz and 1,800 Hz. Controls: electronic crossover. Power: Triamplification system. Response: 30-24,000 Hz \pm 3 dB. 58H x 36W x 6D.\$3,200.

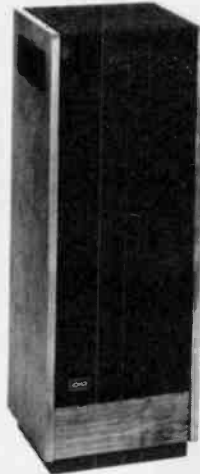
WTLC (Wave Transmission Line Column)
Dual staggered resonance transmission line. Two 8" woofers, two 2" tweeters, 1 Walsh tweeter. CF: 500 Hz, 2,000 Hz, and 8,000 Hz. Controls: mid-tweeter. Rated Z: 6. Power: min., 20; max., 200 (fused). Response: 35-28,000 Hz \pm 4 dB. 41H x 11W x 11D. 55 lbs.\$239.

INTERAUDIO

Model 1000



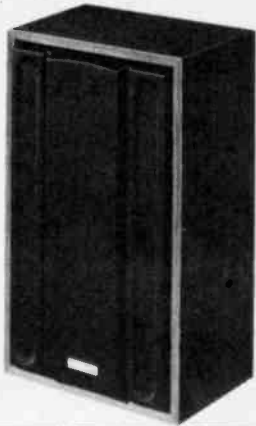
Heath AS-106



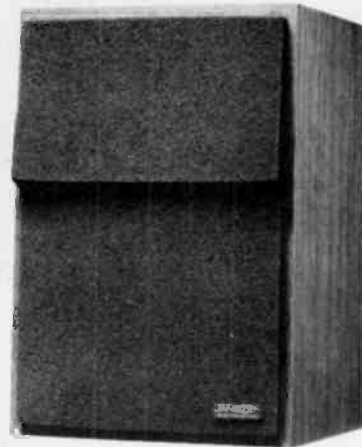
Infinity
Monitor II



Janszen Z-412hp



Interaudio
Model 1000



Janszen Z-210a

Bass reflex. 6" woofer, 1 1/4" tweeter. CF: 2,200 Hz. Rated Z: 8. Power: min., 5; max., 40. 14H x 9W x 7D. 14 1/2 lbs.\$137.80 per pair.

Model 2000

Bass reflex. 8" woofer, 1 1/4" tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 5; max., 50. 20H x 12W x 8D. 23 lbs.\$197.80 per pair.

Model 3000

Bass reflex. 8" woofer, two 1 1/4" tweeters. CF: 1,800 Hz. Rated Z: 8. Power: min., 10; max., 60. 21 1/2H x 13 1/2W x 9D. 34 lbs. \$249.80 per pair.

Model 4000

Acoustic suspension. 10" woofer, two 3" tweeters. CF: 1,700 Hz. Rated Z: 8. Power: min., 20; max., 100. 25 1/2H x 15 1/2W x 11 1/2D. 49 lbs.\$397.80 per pair.

JANSZEN

Z-210a

Acoustic suspension woofer with electrostatic array. 10" woofer, two electrostatic elements. CF: 1,800 Hz. Controls: high-frequency level. Rated Z: 4. Power: min., 15; max., 50. Response: 38-20,000 Hz ± 3 dB. Also available as electrostatic array only Model Z-132W at \$99.95 or unmounted as Model Z-132UM at \$79.95. 17 1/2H x 12 1/2W x 11D. 25 lbs.\$119.95.

Z-210ah

Acoustic suspension woofer with electrostatic array. 10" woofer, two electrostatic elements. CF: 1,800 Hz. Controls: high-frequency level. Rated Z: 4. Power: min., 20; max., 60. Response: 35-20,000 Hz ± 3 dB. Available in kit form at \$129.95. 24H x 13 1/4W x 11D. 39 lbs.\$149.95.

Z-410

Acoustic suspension woofer with electrostatic array. 10" woofer, four electrostatic elements. CF: 1,800 Hz. Controls: high-frequency level. Rated Z: 4. Power: min., 20; max., 75. Response: 35-20,000 Hz ± 3 dB. Electrostatic array available separately as Model Z-134 at \$149.95 or unmounted as Model Z-134UM at \$119.95; also available in kit form at \$149.95. 24H x 13 1/4W x 11D. 41 lbs.\$199.95.

Z-412a

Acoustic suspension woofer with electrostatic array. 12" woofer, four electrostatic elements. CF: 1,800 Hz. Controls: high frequency level. Rated Z: 4. Power: min., 20; max., 100. Response: 33-20,000 Hz ± 3 dB. Electrostatic array available separately as Model Z-134a OW at \$179.95 or unmounted as Model Z-134a UM at \$139.95; also available in kit form at \$199.95. 27 1/2H x 14 1/2W x 11 1/4D. 44 lbs.\$279.95.

Z-412hp

Acoustic suspension woofer with electrostatic array. 12" woofer, four electrostatic elements. CF: 800 Hz. Controls: electrostatic level. Rated Z: 4. Power: min., 20; max., 150. Response: 30-20,000 Hz ± 3 dB. Electrostatic array available separately as Model Z-134hp OW at \$199.95 or unmounted as Model Z-134hp UM or in kit form at \$239.95. 27 1/2H x 14 1/2W x 11 1/4D. 48 lbs.\$319.95.

Z-824

Acoustic suspension woofer with electrostatic array. Two 12" woofers, eight electrostatic elements. CF: 800 Hz. Controls: electrostatic level. Rated Z: 4. Power: min., 20; max., 300. Response: 30-20,000 Hz ± 3 dB. Electrostatic

available separately as Model Z-138 OW at \$299.95 or unmounted as Model Z-138 UM at \$249.95. Pecan finish. 31 1/2H x 29W x 19 1/4D. 120 lbs.\$695.

JBL

L16 Decade

Ducted port. 8" woofer, 1.4" tweeter. CF: 2,500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 60. Oak finish. 10 1/2H x 19 1/4W x 10 1/4D. 28 lbs.\$99.

L25 Decade

Ducted port. 10" woofer, 1.4" tweeter. CF: 2,000 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 60. Choice of grille colors, oak finish. 12 3/4H x 24W x 13 1/4D. 42 lbs.\$156.

L35 Decade

Ducted port. 10" woofer, 5" midrange, 1.4" tweeter. CF: 1,500 Hz and 6,000 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 100. Optional grille colors, oak finish. 13 1/2H x 24W x 13 3/4D. 45 lbs.\$198.

L65 Jubal

Ducted port. 12" woofer, 5" midrange, slot-loaded radiator. CF: 1,000 Hz and 6,500 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 150. Manufacturer claims 110 degree horizontal dispersion at 20,000 Hz. 3 dimensional grille, choice of colors. 24 1/2H x 17 1/2W x 13 1/4D. 67 lbs.\$426.

L100 Century

Ducted port. 12" woofer, 5" midrange, 1.4" tweeter. CF: 1,500 Hz and 6,000 Hz. Controls:

mid and high frequencies. Rated Z: 8. Power: min., 10; max., 150. Choice of grille colors. 14 $\frac{1}{4}$ "H x 23 $\frac{1}{2}$ "D x 13 $\frac{3}{8}$ "W. 55 lbs.\$318.

S109 Aquarius Four

Ducted port (with low- and high-loading elements). 8" woofer, 2" tweeter. CF: 6,000 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 75. Diffraction slot enclosure; manufacturer claims 360 degree horizontal and 180 degree vertical dispersion. 40H x 10W x 10D. 57 lbs.\$210.

L120 Aquarius Q

Ducted port (individual low- and mid-frequency diffusers). 10" woofer, 5" midrange, 1.4" tweeter. CF: 1,000 Hz and 8,000 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 100. Manufacturer claims 360 degree horizontal and 120 degree vertical dispersion, placement not dependent on room surfaces. Choice of walnut or satin white finish, optional grille colors, smoked glass top. 44H x 12W x 12D. 71 lbs.\$633.

L166 Horizon

Ducted port. 12" woofer, 5" midrange, 1" dome tweeter. Controls: mid and high frequencies. CF: 1,000 Hz and 6,000 Hz. Rated Z: 8. Power: min., 10; max., 150. Will not be available until Fall 1975. Perforated 3 dimensional grille. 23 $\frac{1}{2}$ "H x 14 $\frac{1}{4}$ "W x 13D. 55 lbs.\$375.

L200B Studio Master

Ducted port. 15" woofer; compression driver, horn and acoustic lens. CF: 800 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 150. Slanted grille in choice of colors. 32 $\frac{3}{4}$ "H x 23 $\frac{3}{8}$ "W x 21 $\frac{1}{4}$ "D. 131 lbs.\$696.

L300 Summit

Ducted port. 15" woofer; compression driver, horn and acoustic lens; slot-loaded radiator. CF: 800 Hz and 8,500 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 150. 3-dimensional grille, in choice of colors. 31 $\frac{1}{2}$ "H x 23W x 22 $\frac{1}{2}$ "D. 145 lbs.\$897.

S507 Olympis (with S7R system)

Bass reflex, passive radiator. 15" woofer; 15" passive radiator; compression driver, horn, and acoustic lens. CF: 500 Hz. Controls: high frequency. Rated Z: 8. Power: min., 10; max., 150. Fretwork grille. 26 $\frac{1}{2}$ "H x 40W x 20D. 163 lbs.\$837.

S508 Olympis (with S8R system)

Bass reflex, passive radiator. 15" woofer; 15" passive radiator; compression driver, horn, and acoustic lens; ring radiator. CF: 500 Hz and 7,000 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 150. 26 $\frac{1}{2}$ "H x 40W x 20D. 180 lbs.\$1,098.

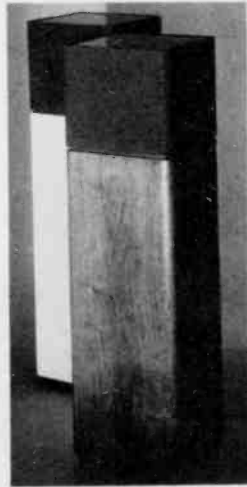
D44000 Paragon

Horn-loaded, radial refraction for mid and high. Two 15" woofers, two compression drivers with elliptical horns, two ring radiators. CF: 500 Hz and 7,000 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 150. 36H x 104W x 24D. 695 lbs.\$3,210.

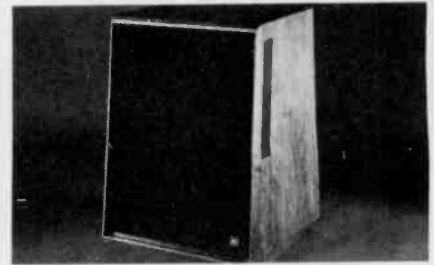
JENNINGS RESEARCH

Contrara P

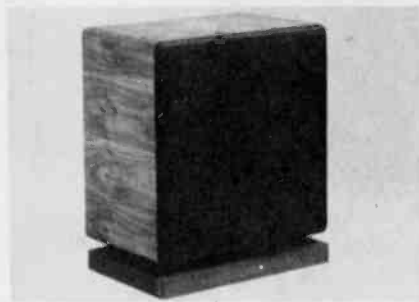
Air suspension. Two 8" woofers, 1" soft



JBL L120 Aquarius Q



JBL L200B Studio Master



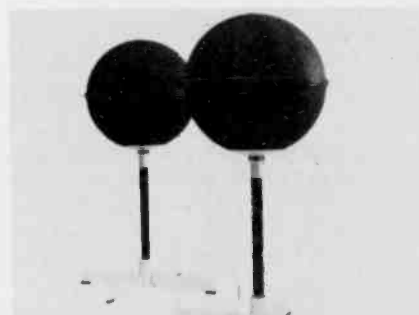
Jennings Research Contrara S



Jensen Serenata Model 15



Jensen Model 23



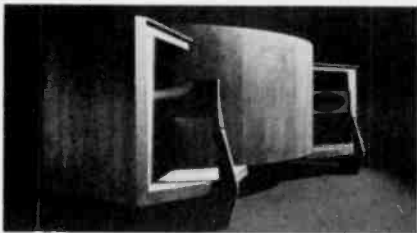
JVC VS 5313



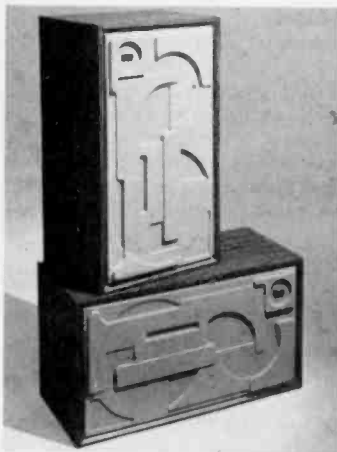
Kenwood LS-403



Jennings Research
Contrara P



JBL D44000 Paragon



JVC-3



Kenwood Model Nine

domed tweeter. CF: 1,750 Hz. Rated Z: 5. Power: min., 7½; max., 150. Response: 38-20,000 Hz, ref. 90 dB/SPL. Pedestal mounted, rotates 360 degrees. 33H x 11½W x 11½D. 42 lbs.....\$225.

Contrara R

Air suspension. 8" woofer, 1" soft-dome tweeter. CF: 1,750 Hz. Rated Z: 5. Power: min., 10; max., 100. Response: 50-20,000 ± 3 dB, ref. 90 dB/SPL. Built-in base and snap-off grilles. Fuse protection. 12H x 18W x 9½D. 30 lbs.....\$125.

Contrara S

Air suspension. 8" woofer, 1" soft dome tweeter. CF: 1,750 Hz. Rated Z: 5. Power: min., 10; max., 100. Response: 50-20,000 Hz ± 3 dB, ref. 90 dB/SPL. Square bookshelf system with built-in base and snap-off grilles, fuse protection. 15½H x 15W x 9½D. 30 lbs.....\$125.

JENSEN

Serenata Model 15

Tuned port. 15" Flexair woofer, 8" direct radiating midrange, 5" direct radiating, rear damped tweeter, two 1" sound dome ultra-tweeters. CF: 300 Hz, 1,500 Hz, and 4,000 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 10; max., 100. Response: 25-30,000 Hz. Bottom-mounted push binding posts for concealed wiring, removable sculptured grille, 31H x 23W x 17D. 100 lbs.\$426.

Model 21

Acoustic suspension. 8" Flexair woofer, 2" cone tweeter. CF: 4,000 Hz. Controls: continuously variable performance. Rated Z: 8. Power: min., 10; max., 40. Response: 35-20,000 Hz. Two-tone brown grille, dust cover, push-type binding posts. 18¼H x 11W x 8¾D. 18 lbs.....\$69.

Model 22

Acoustic suspension. 10" Flexair woofer, 2" cone tweeter. CF: 4,000 Hz. Controls: continuously variable performance. Rated Z: 8. Power: min., 10; max., 45. Response: 32-20,000 Hz. Two-tone brown grille, dust cover, push-type binding posts. 22½H x 12¼W x 10¼D. 28 lbs.....\$99.

Model 23

Acoustic suspension. 10" Flexair woofer, 1½" dome tweeter. CF: 1,000 Hz. Controls: continuously variable performance. Rated Z: 8. Power: min., 10; max., 60. Response: 27-25,000 Hz. Two-tone brown grille, dust cover, push-type binding posts. 24H x 13W x 12D. 40 lbs.....\$129.

Model 24

Acoustic suspension. 12" Flexair woofer, 3" direct radiating Flexair midrange, 1½" dome

tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 75. Response: 25-25,000 Hz. Two-tone brown grille, dust cover, and push-type binding posts. 26H x 15W x 13D. 50 lbs.....\$179.

JVC

JVC-3

Air suspension. 10" woofer, soft-dome tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 13; max., 50. Optional chasmere tan or orange grille. 23¾H x 13¼W x 10¼D. 33 lbs.....\$169.95.

SX-3

Air suspension. 10" woofer, 2" soft dome tweeter. CF: 2,000 Hz. Controls: separate bass and tweeter level. Rated Z: 8. Power: min., 20; max., 50. Response: 35-20,000 Hz, ref. 88 dB/SPL at 1 meter. Edgeless cabinet. 20½H x 12¾W x 11 7/16D. 29 lbs.....\$159.95.

VS 5313

Hermetically sealed globe. Four 5" woofers, four 2" tweeters. CF: 5,000 Hz. Rated Z: 8. Power: min., 20; max., 80. Response: 30-20,000 Hz, ref. 94 dB. Manufacturer claims 360 degree dispersion; can be used with stand or suspended from ceiling. 13½" sphere. 26½ lbs.....\$229.95.

KENWOOD

LS-403

Bass Reflex. 8" woofer, 1¼" tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 20; max., 40. Response: 65-20,000 Hz. 17¾H x 11¼W x 8¾D. 20 lbs.....\$84.95.

LS-405

Bass reflex. 10" woofer, 1" dome tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 30; max., 50. Response: 58-20,000 Hz. 23¼H x 12¼W x 11D. 31 lbs.....\$119.95.

LS-406

Bass reflex. 10" woofer, 1" dome tweeter. CF: 2,000 Hz. Controls: tweeter attenuator. Rated Z: 8. Power: min., 30; max., 60. Response: 48-20,000 Hz. 25¼H x 15W x 12½D. 38 lbs.....\$149.95.

Model Seven

Acoustic suspension. 14" woofer, 4¾" mid-range, 1½" tweeter, ¾" super-tweeter. CF: 400 Hz, 4,000 Hz, and 8,000 Hz. Controls: mid-range and tweeter. Rated Z: 8. Power: min., 100; max., 150. Response: 20-35,000 Hz ± 5 dB, ref. 94 dB. 37H x 18¾W x 15D. 121 lbs.....\$1,350.

Model Nine

Back-loaded horn. Two 14" low frequency; exponential horn with acoustic lens. CF: 600 Hz. Controls: high-frequency attenuator. Rated Z: 8. Power: min., 100; max., 200. Response: 30-18,000 Hz. 264 lbs.....\$2,400.

KING RESEARCH

The Frankmann

Infinite baffle. Eight 12" woofers, eight over-tone horn drivers, eight 8" tweeters. CF: 200 Hz and 5,000 Hz. Rated Z: 8. Power: min., 10; max., 200. Response: 20-18,000 Hz ± 4 dB,

Understanding the Numbers

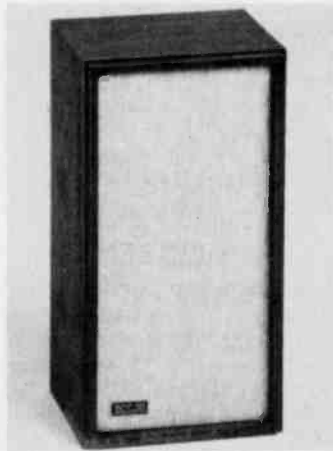
For detailed explanations of the technical "shorthand" used in the equipment directory, the reader is invited to study the articles in this volume, especially those dealing with how speakers work, and how they are evaluated.



KLH Twenty-Eight



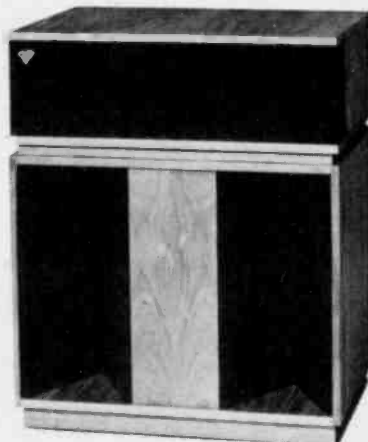
KLH Research X Column Bookshelf



KLH Seventeen



Klipsch Kilpschorn



Klipsch Belle Klipsch

ref. 98 dB/SPL. System consists of 1 common base unit and 2 satellites, fuse protection, 5-yr. warranty. Utility model of birch wood without cabinet design for custom installation for \$1,495. Bass unit, 31H x 52¼W x 25¼D; satellite, 43¼H x 10W x 6½D. 250 lbs.\$1,995.

KLH

Five

Acoustic suspension. 12" woofer, two 3" mid-range, 1¾" tweeter. CF: 2,500 Hz and 7,000 Hz. Controls: 3-position mid- and high-frequency switches. Rated Z: 8. Power: min., 18; max., 100. A 3-way system. 26H x 13¼W x 11½D. 44 lbs.\$225.

Six

Acoustic suspension. 12" woofer, 1¾" direct-radiating tweeter. CF: 1,500 Hz. Controls: 3-position high-frequency level switch. Rated Z: 8. Power: min., 15; max., 100. 23½H x 12¾W x 11¾D. 43 lbs.\$149.95.

Seventeen

Acoustic suspension. 10" woofer, 1¾" direct radiating tweeter. CF: 1,500 Hz. Controls: 3-position high frequency level switch. Rated Z: 8. Power: min., 8; max., 100. 23½H x 11¾W x 9D. 24 lbs.\$89.95.

Twenty-Three

Acoustic suspension. 12" woofer, 1¾" direct radiating tweeter. CF: 1,500 Hz. Controls: 3-position high frequency level switch. Rated Z: 8. Power: min., 15; max., 100. 25¼H x 14½W x 11½D. 39½ lbs.Price not available.

Twenty-Eight

"Omnireflective" acoustic suspension. Three 10" woofers, three 1¾" tweeters. CF: 1,500 Hz. Controls: Acoustic projection switch, separate front and rear high-frequency level switch. Rated Z: 8. Power: min., 30; max., 100. A two-way system. 18¾H x 25¼W x 16¾D; pedestal, 13 inches high; 18 inches in diameter at bottom. 94 lbs; pedestal, 8½ lbs.\$229.95.

Thirty-One

Acoustic suspension. 8" woofer, 1¾" tweeter. CF: 1,750 Hz. Rated Z: 8. Power: min., 8; max., 100. 17½H x 10¾W x 8¼D. 16 lbs.\$99.95 per pair.

Thirty-Two

Acoustic suspension. 8" woofer, 1¾" tweeter, CF: 1,750 Hz. Rated Z: 8. Power: min., 10; max., 100. 19¾H x 10¾W x 7 3/16D. 17 lbs.\$125 per pair.

Thirty-Three

Controlled acoustic compliance. 10" woofer, 1¾" tweeter. CF: 1,500 Hz. Controls: 3-position high-frequency level switch. Rated Z: 8. Power: min., 10; max., 100. 23¾H x 12¾W x 10 5/16D. 33 lbs.\$110.

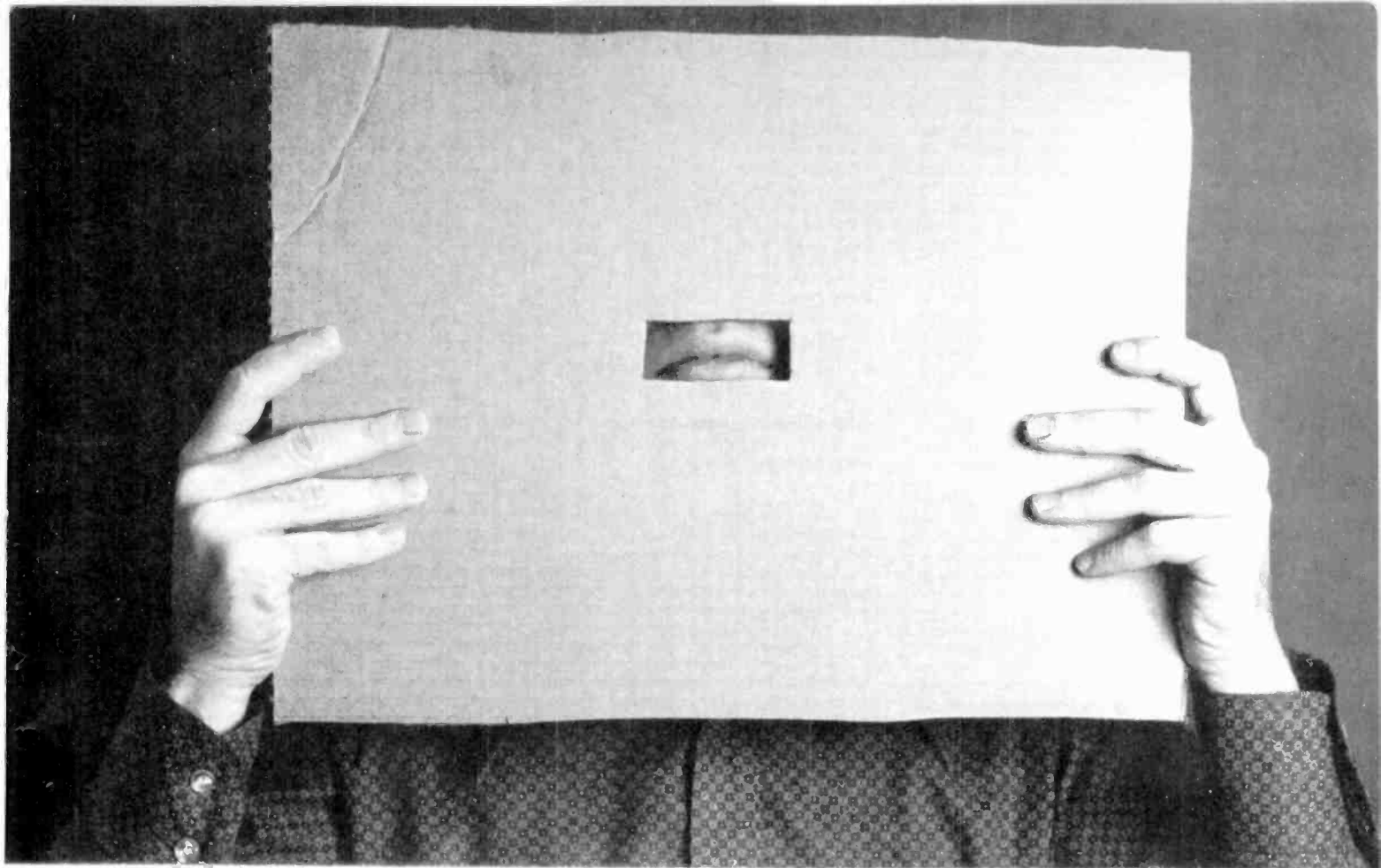
Thirty-Eight

Acoustic suspension. 10" woofer, 1¾" tweeter, CF: 1,800 Hz. Rated Z: 8. Power: min., 15; max., 100. 21¼H x 12¾W x 8½D. 23 lbs.\$149.95 per pair.

KLH RESEARCH X

Classic Four

Acoustic suspension. 12" woofer, two 1¾"



Turn yourself into a remarkable speaker demonstration.

To begin, just find a piece of heavy cardboard or corrugated carton about 14" x 20" and cut an opening in the center like the one above. Now you're ready! Grab a friend, your wife, your mother-in-law—anyone who can bear to hear you ramble on for the next 30 seconds. Hold the contraption you just made to your face so that your lips are against the opening and start talking. Now, take it away quickly as you continue to talk. Then hand it over and let the other person talk, with and without the cardboard.

If all went well, you probably noticed a coloration in voice quality whenever the cardboard was held up.

In essence, what you just did was to simulate the way every enclosure type of system is affected by the baffle board its speakers are mounted on. You became the speaker and the cardboard became the baffle.

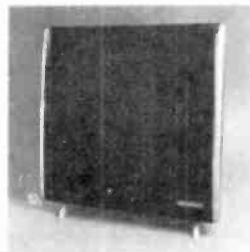
As you spoke without the cardboard, the sound waves reached the listener normally. But when you spoke holding up the cardboard, some of the sound waves from your voice traveled along the surface of the cardboard until they

reached the edges, the way they do on a conventional speaker. The sharp discontinuity caused an effect called "diffraction," which allows these waves to be heard too, but later than the original sound. This is what produces the unnatural coloration you heard.

But the Dahlquist DQ-10 overcomes this problem through an ingenious free-air mounting configuration which has no large baffle surfaces to color the sound. At the same time we are able to reduce time-delay distortion, since all drivers are mounted in the correct acoustical plane.

The end result is sound that is so natural and open in quality that you will realize just how much coloration enclosure type speakers produce. Even if you don't want to go to the trouble of

doing our little home demonstration, any Dahlquist Dealer will be happy to do it for you, using a DQ-10 instead.



DAHLQUIST
The boxless speaker

27 Hanse Ave., Freeport, N.Y. 11520

tweeters. CF: 1,500 Hz. Controls: 2-position high-frequency switch. Rated Z: 8. Power: min., 25; max., 150. Response: 38-15,000 Hz +1/-2 dB. 26 1/3" H x 14 1/4" W x 13 1/2" D. 52 lbs. \$170.

Column Bookshelf

Controlled acoustic compliance, 8" patented magnet/long excursion woofer, 2 1/4" direct radiating tweeter. CF: 2,000 Hz. Controls: 3-position frequency level switch. Rated Z: 8. Power: min., 15; max., 150. Response: 60-20,000 Hz ± 3 1/2 dB. 19 1/2" H x 11" W x 7 1/4" D. 23 lbs. \$85.

KLIPSCH

Belle Klipsch

Horn loaded, K-33 woofer, K-55-V midrange, K-77 tweeter. CF: 400 Hz and 6,000 Hz. Rated Z: 8. Power: max., 100. Response: 45-17,000 Hz ± 5 dB. 35 1/2" H x 30 3/8" W x 18 1/2" D. 125 lbs. \$840.

Cornwall

Direct radiator, horn-loaded ducted port, K-33 woofer, K-55-V midrange, K-77 tweeter. CF: 600 Hz and 6,000 Hz. Rated Z: 8. Power: max., 100. Response: 38-17,000 Hz ± 5 dB. 35 1/4" H x 25 1/2" W x 15 1/2" D. 108 lbs. \$394 \$525.

Heresy

Direct radiator bass, horn-loaded midrange and tweeter, K-22 woofer, K-55-V or K-56 midrange (interchangeable), K-700 horn, K-77 tweeter. CF: 700 Hz and 6,000 Hz. Rated Z: 8. Power: max., 100. Response: 50-17,000 Hz ± 5 dB. 21 1/2" H x 15 1/2" W x 13 1/2" D. 55 lbs. \$248 \$297.

Klipschorn

Horn-loaded throughout, K-33 woofer, K-55-V midrange, K-77 tweeter. CF: 400 Hz and 6,000 Hz. Rated Z: 8. Power: max., 100. Response: 35-17,000 Hz ± 5 dB. 52 1/2" H x 31 1/2" W x 28 1/2" D (front to corner). 180-240 lbs., depending on style. \$675 \$1,441.

La Scala

Horn-loaded throughout, K-33 woofer, K-55-V midrange, K-77 tweeter. CF: 400-6,000 Hz. Rated Z: 8. Power: max., 100. Response: 45-17,000 Hz ± 5 dB. 34 1/2" H x 23 1/4" W x 24 1/2" D. 110 lbs. \$525.

KOSS

Model One

Full-range Electrostatic. Rated Z: 4. Power: min., 75; max., 300. Response: 30-20,000 Hz ± 3 dB. 49" H x 32" W x 10" D. 150 lbs. \$895.

KUSTOM ACOUSTICS

Colossus

TAL (Tapered Acoustical Line). Eight 12" woofers, four 5" midranges, four 1" dome tweeters. CF: 775 Hz and 3,500 Hz. Rated Z: 1, 2, or 4. Power: min., 15; max., 1,250. Optional grille colors, 60 optional veneers available, bi- and tri-amplification available, fuse protection, water-proof finish available. 72" H x 36" W x 20" D. \$1,695.

FSM II (Floor Standing Monitor)

TAL. 12" woofer, 1 1/4" semi-dome tweeter.

CF: 1,800 Hz. Controls: continuously variable T-pad for tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as listed under Colossus, plus fired pewter top, var-i-vent (allows system resonance to be adjusted ± 5 dB). 30" H x 17" W x 13" D. 80 lbs. \$329.

FSM III

TAL. 12" woofer, 5" midrange, 1 1/4" semi-dome tweeter. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads for midrange and tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the FSM II. 30" H x 17" W x 13" D. 88 lbs. \$379.

SJM II (Super Jumbo Monitor)

TAL. 12" woofer, 1 1/4" semi-dome tweeter. CF: 1,800 Hz. Controls: continuously variable T-pad for tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the Colossus, plus paralleled beveled sides. 27" H x 17" W x 11" D. 65 lbs. \$249.

SJM III

TAL. 12" woofer, 5" midrange, 1 1/4" semi-dome tweeter. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads for midrange and tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the SJM II. 27" H x 17" W x 11" D. 73 lbs. \$299.

SMT II (Studio Monitor Tower)

TAL. 12" woofer, 1 1/4" semi-dome tweeter. CF: 1,800 Hz. Controls: continuously variable T-pad on tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the Colossus, plus imitation slate top. 36 1/2" H x 16" W x 13" D. 95 lbs. \$419.

SMT III

TAL. 12" woofer, 5" midrange, 1" dome tweeter. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads on midrange and tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the SMT II. 36 1/2" H x 16" W x 13" D. 103 lbs. \$479.

SMTL (Studio Monitor Tower Labyrinth)

TAL and transmission line. 12" woofer, 5" midrange, 1" tweeter. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads for midrange and tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the Colossus; standard veneer of Brazilian rosewood. 36" H x 16" W x 16" D. \$569.

ST II (Studio Tower)

TAL. 12" woofer, 1 1/4" semi-dome tweeter. CF: 1,800 Hz. Controls: continuously variable T-pad on tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as the Colossus plus an imitation slate top. 32" H x 15 1/2" W x 12" D. 75 lbs. \$339.

ST III

TAL. 12" woofer, 5" midrange, 1 1/4" semi-dome tweeter. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads for midrange and tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as ST II. 32" H x 15 1/2" W x 12" D. 83 lbs. \$389.

STL (Studio Tower Labyrinth)

TAL and transmission line. 12" woofer, 5" midrange, and 1 1/4" semi-dome tweeter. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads for midrange and tweeter. Rated Z: 8. Power: min., 15; max., 250. Same features as Colossus, plus imitation slate top. 44" H x 15 1/2" W x 14" D. 105 lbs. \$649.

TDS (Theatre/Discotheque System)

TAL. Four 12" woofers, two 5" midranges, two 1" dome tweeters. CF: 775 Hz and 3,500 Hz. Rated Z: 2 or 8. Power: min., 15; max., 300 at 8 ohms, 600 at 2 ohms. Same features as Colossus. 48" H x 30" W x 18" D. 280 lbs. \$999.

TSM (Theatre System and Monitor)

TAL. Two 12" woofers, 5" midrange, 1" dome tweeter. CF: 775 Hz and 3,500 Hz. Rated Z: 4. Power: min., 15; max., 300. Same features as Colossus. 26" H x 23" W x 16" D. 165 lbs. \$689.

TSM III

TAL. Same features as the TSM. 174 lbs. \$749.

Titan Labyrinth

TAL and transmission line. Two 12" woofers, two 5" midranges, two 1 1/4" semi-dome tweeters. CF: 775 Hz and 3,500 Hz. Controls: continuously variable T-pads on both midranges and tweeters. Rated Z: 4. Power: min., 15; max., 300. Same features as Colossus plus standard veneer ebony finish. 48" H x 30" W x 16" D. \$1,489.

LAFAYETTE

Criterion L-2

Acoustic suspension, 8" woofer, 3" midrange, 3" tweeter. CF: 6,000 Hz and 9,000 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 50-20,000 Hz. Removable grille. 16 1/2" H x 10 1/2" W x 7 1/2" D. 16 lbs. \$39.95.

Criterion L-4

Ported bass, 8" woofer, 3" midrange, 2 1/4" tweeter. CF: 4,500 Hz and 9,000 Hz. Rated Z: 8. Power: min., 8; max., 40. Response: 40-20,000 Hz. Removable grille. 21" H x 12" W x 8 1/2" D. 24 lbs. \$49.95.

Criterion L-6

Acoustic suspension, 10" woofer, 5" midrange, CF: 2,200 Hz and 6,000 Hz. Controls: separate mid and high frequency. Rated Z: 8. Power: min., 10; max., 50. Response: 30-22,000 Hz. Removable grille. 22 1/4" H x 13 1/4" W x 10 1/2" D. 35 lbs. \$79.95.

Criterion 666

Acoustic suspension, 10" woofer, 6" midrange, 2" super-tweeter. CF: 800 Hz and 5,000 Hz. Controls: separate mid and high frequency. Rated Z: 8. Power: min., 10; max., 60. Response: 28-20,000 Hz ± 5 dB, ref. 90 dB. 22" H x 14 1/2" W x 11" D. 31 lbs. \$119.95.

Criterion 777

Acoustic suspension, 10" high compliance

Monthly Reports on Speakers

For detailed laboratory reports on all types of new equipment, including speaker systems, read the monthly issues of HIGH FIDELITY magazine. In addition, test reports are updated and collected yearly in the special publication "HIGH FIDELITY'S TEST REPORTS." Reports are based on lab measurements and controlled listening tests. Manufacturers are not permitted to read reports in advance of publication.

The new Sansui LM Loudspeakers that set the AES Convention on its ears.



LM 330
CUT-A-WAY

At the Convention of the Audio Engineering Society in Los Angeles last May, Sansui demonstrated a new concept in loudspeaker design.

The reception from these experts—chief engineers of radio and TV stations, record producers, recording engineers and sales executives of audio companies—was even more sensational than we ourselves expected.

And these are the reasons:

Unlike conventional speakers, the LM design incorporates a multi-radiational tweeter device. High frequencies instead of being lost through encapsulation, are diverted through three special exponential horns and recovered into sound energy that

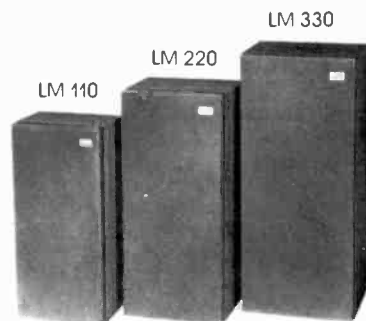
adds a breathtaking sense of ambience, and realism. The LM speakers also display extremely stable and well-defined stereo images. At the same

time, both the transient response and efficiency of the system are greatly increased. An extra large woofer assembly gives exceptionally strong bass response ordinarily available only in much larger and more expensive speakers.

Hear any of the 3 models available at your nearest Sansui franchised dealer. You never heard music so alive before.



Multi-radiational
tweeter



SANSUI ELECTRONICS CORP.

Woodside, New York 11377 • Gardena, California 90247

SANSUI ELECTRIC CO., LTD., Tokyo, Japan • SANSUI AUDIO EUROPE S.A.,
Antwerp, Belgium • ELECTRONIC DISTRIBUTORS (Canada) Vancouver 9, B.C.



LINEAR DESIGN LABS

44

Acoustic suspension. Two 4½" full-range drivers. Rated Z: 8. Power: min., 5; max., 50. Response: 45-20,000 Hz. 5-yr. warranty. 14H x 8W x 8D. 15 lbs.\$125 per pair.

802

Acoustic suspension. Ten 4½" full-range drivers. Rated Z: 8. Power: min., 20; max., 330. Response: 30-20,000 Hz. Six-sided cabinet. 5-yr. warranty. 12H x 19¼W x 12½D. 43 lbs.\$425.

1243

Acoustic suspension. 12" woofer. 4½" mid-range, piezoelectric tweeter. Rated Z: 8. Power: min., 5; max., 50. Response: 30-35,000 Hz. 5-yr. warranty. 25H x 15W x 11½D. 40 lbs.\$450 per pair.

LINEAR SOUND

Model 200

Acoustic suspension. 12" woofer, 1" dome tweeter. Rated Z: 4. Power: min., 20; max., manufacturer claims system can handle up to 200 watt musical peaks. Response: 35-18,000 Hz ± 4 dB. Fuse protected. 5-yr. warranty. 27H x 16W x 14D.\$189.

Model 300

Acoustic suspension. 12" woofer, 5" mid-range, 2¼" tweeter. Rated Z: 4. Power: min., 25; max., manufacturer claims system can handle greater than 450 watt musical peaks. Response: 35-20,000 Hz ± 3.5 dB. Fuse protected. 5-yr. warranty. 27H x 16W x 14D.\$269.

MAGITRAN

D560

Infinite baffle. Two polyplanar 4-way speakers. Rated Z: 4-8. Power: min., 5; max., 28. Response: 40-20,000 Hz ± 3 dB. ref. 85 dB/SPL. Thin panel design, interchangeable grille cloths. 29¾H x 23¾W x 2D. 13 lbs.\$89.95.

E41

Infinite baffle. Polyplanar 4-way speaker. Rated Z: 4-8. Power: min., 2; max., 25. Response: 50-20,000 Hz ± 3 dB. ref. 85 dB/SPL. Fully waterproof, for outdoor use; available in white or brown. 13¼H x 16¼W x 2D. 4 lbs.\$24.95.

MAGNEPAN

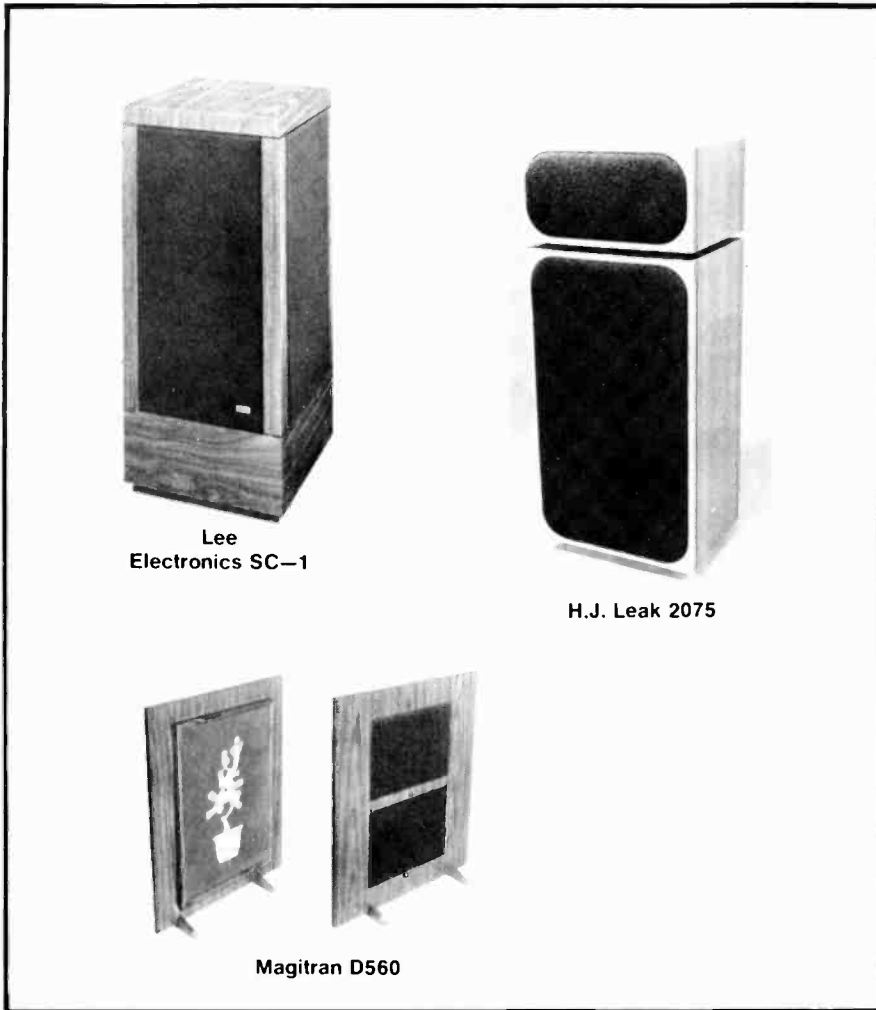
MG-II (formerly MG-2167-F)

Magneplanar diaphragm. Bass/midrange section 500 sq. in., tweeter section 85 sq. in. CF: 2,400 Hz. Rated Z: 6. Power: min., 30; max., 200. Response: 50-18,000 Hz ± 4 dB. ref. 85 dB/SPL at 3 feet. Made in left- and right-channel units. 71H x 22W x 2D. mounted on 22" x 14" bass plate. 41 lbs.\$625 per pair.

MAGNUM OPUS

LAB 8

"Dynamic damping system." Two 10" woofers, 5" midrange, two cone tweeters, two dome tweeters, piezoelectric tweeter. CF: 750 Hz. 3,000 Hz, and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 4. Power: min., 15; max., 100. Response: 25-45,000 Hz. Circuit



Lee
Electronics SC-1

H.J. Leak 2075

Magitran D560

woofer, 6" midrange, 2" dome center cone tweeter. CF: 800 Hz and 4,000 Hz. Controls: separate midrange and high frequency. Rated Z: 8. Power: min., 15; max., 80. Response: 50-14,000 Hz ± 3 dB. 23H x 15W x 12D. 36 lbs.\$139.95.

H. J. LEAK

2020

Acoustic suspension. 170 mm "sandwich" bass/midrange 30mm cone tweeter. CF: 3,500 Hz. Rated Z: 4-8. Power: min., 5; max., 25. Response: 45-20,000 Hz ± 3 dB. 15¼H x 9¾H x 9¼W. 15 lbs.\$135.

2030

Bass reflex. 200 mm "sandwich" woofer, 100 mm cone midrange, 25 mm dome tweeter. CF: 700 Hz and 3,500 Hz. Rated Z: 4-8. Power: min., 5; max., 35. Response: 40-20,000 Hz ± 2 dB. 19¼H x 11W x 10¼D. 24½ lbs.\$195.

2060

Acoustic suspension. 300 mm "sandwich" woofer, 100 mm cone midrange, 25 mm tweeter. CF: 600 Hz and 3,500 Hz. Rated Z: 4-8. Power: min., 5; max., 50. Response: 35-20,000 Hz. The midrange unit has a rear loading transmission line. 25½H x 15W x 13D. 51 lbs.\$325.

2075

Transmission line. 380 mm "sandwich"

woofer, lower midrange unit, upper midrange unit, 25 mm dome tweeter. CF: 450 Hz, 2,000 Hz, and 5,000 Hz. Rated Z: 8. Power: min., 10; max., 100. Response: 35-20,000 Hz. 47H x 19¼W x 14¼D. 112 lbs.\$875.

LEE ELECTRONICS

LD-8

Tuned transmission line. 8" woofer/midrange, 3" sealed back cone tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 3; max., 17. Removable grille baffle, comes with RCA pin jack and screw type terminal. 18H x 11W x 12D. 25 lbs.\$44.95.

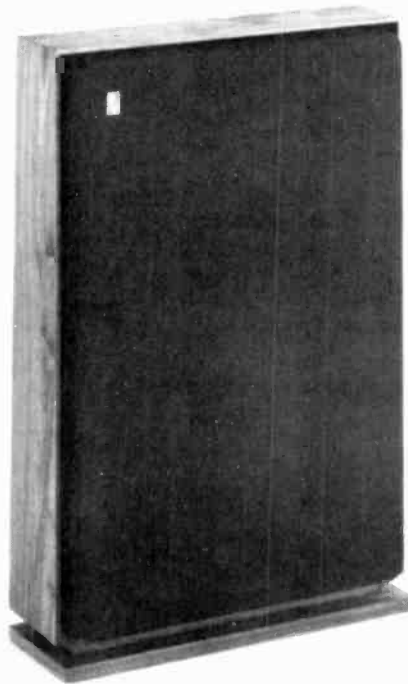
P-100

Acoustic suspension. 12" woofer, 5" midrange, two 3" phenolic ring cone super-tweeters. CF: 500 Hz and 2,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 5; max., 40. Response: 25-18,000 Hz. Removable grille baffle, RCA pin jack and screw-type terminal. 24H x 15W x 12D. 43 lbs.\$69.95.

SC-1

Non-directional piston drive. 8" x 6" "Lee" woofer, 5" x 3.5" "Lee" tweeter. CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 3; max., 40. Response: 25-16,000 Hz. Removable (4) grille baffles, RCA pinjack and screw type terminal. 32H x 14 3/16 square. 62 lbs.\$149.95.

The impossible dream.



Since 1871 electrostatic speakers have been but a promise; today the Koss Model One has made them a reality.

Unlike most ads, this ad wasn't written for everybody. In truth, it was meant for a very small number of discerning audio enthusiasts who have dreamed an impossible dream about electrostatic speakers. And who have continually been disappointed.

For those who have dreamed the impossible, Koss has developed a full-range electrostatic speaker that reproduces the lowest to the highest octaves of music with an authority never achieved in previous electrostatic speakers. Once you've heard it, we think you'll agree. Until you do, let us tell you why.

First, the Koss Model One isn't another hybrid. The bandpass of 30 Hz to 250 Hz is reproduced by an electrostatic woofer that features over 19 sq. ft. of diaphragm surface area. No other speaker, electrostatic or dynamic, has ever reproduced the clarity and power of the lowest audible octaves like the Koss Model One. Impossible? Just listen to it.

Second, the Model One represents, to our knowledge, the first 4-way design ever offered in electrostatic speakers. This design approach has allowed Koss to offer the world's first electrostatic woofer capable of playing at concert hall levels. In addition, a unique midrange panel was designed specifically to avoid the bigger-than-life spacial distortion plaguing other large-panel speakers. In other words, a violin sounds like it is normal-size rather than as big as a

cello. The treble and tweeter panel designs were also critically matched to the wavelength requirements of their respective bandpasses. The resulting smoothness of response and uniform dispersion of energy from top to bottom establishes a new precedent in naturalness and clarity of reproduced sound.

Third, a major design breakthrough has been achieved in the Model One crossover system. And we think it's a uniquely patentable system. Instead of the expected plurality of additional coils, capacitors and resistors normally needed to achieve a 4-way crossover, the Model

One uses no other components than those needed to drive the separate acoustic panels. In other words, step-up transformers which provide the drive voltage to each of the four bandpasses also function as the crossovers. This unique transformer design eliminates the need for additional bulky, expensive, distortion-producing components that, until now, made a reasonably-priced but high performance full-range electrostatic system impossible.

Fourth, another innovative design feature of the Model One is the use of a frequency-sensitive attenuator that protects the speaker from unwanted sub-sonic signals below the 30 Hz level as well as potentially dangerous DC voltages from the amplifier.

And fifth, there's a patented Auto-Charge Bias Supply that eliminates the need for an AC cord. Imagine an electrostatic speaker system without the old "AC umbilical cord"! Or for that matter, without the obvious electrical dangers. If that isn't worth hearing, what is?

Your Audio Specialist will be happy to show you the fulfillment of the electrostatic promise. We don't think you'll be disappointed in what you hear. Nor in what you buy. But then, the Koss Model One isn't for everybody.

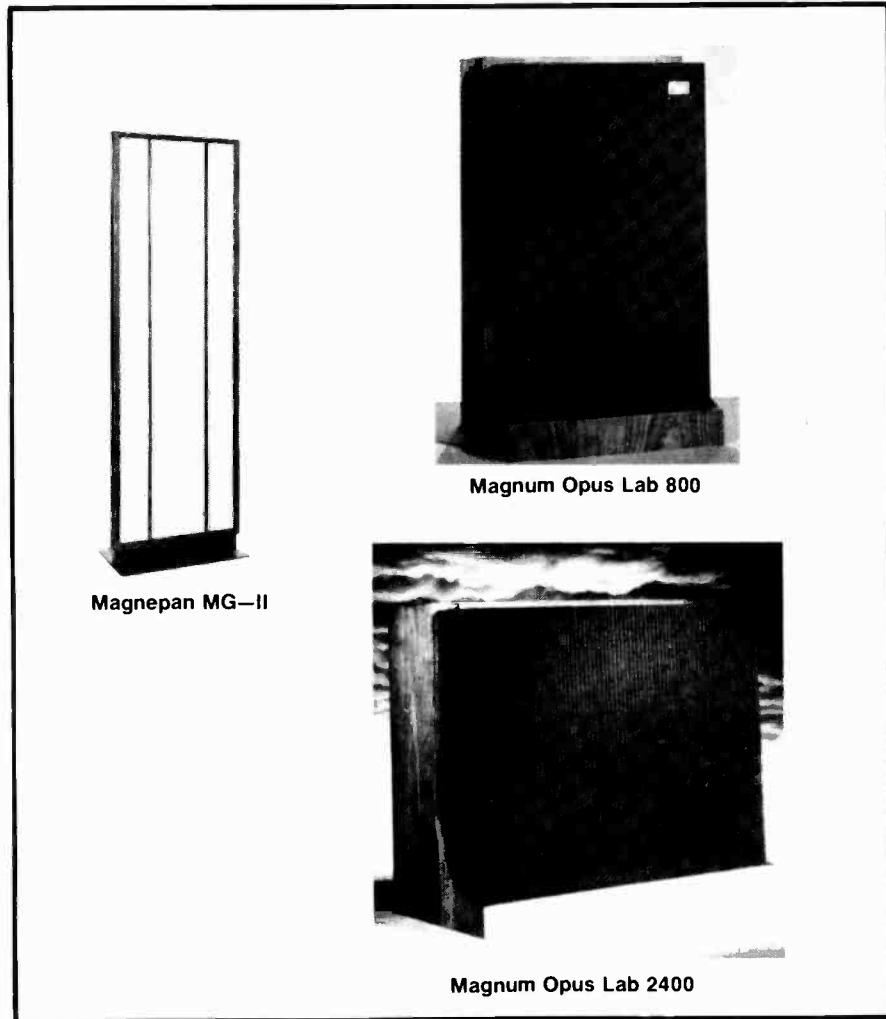
©Koss Corporation

the fulfillment of the electrostatic promise

KOSS Model One electrostatic speaker

KOSS CORPORATION, 4129 N. Port Washington Ave., Milwaukee, Wisconsin 53212 • Koss International/London, Milan, Dublin, Paris, Frankfurt • Koss Limited/Ontario

CIRCLE 18 ON READER-SERVICE CARD



Magnepan MG-II

Magnum Opus Lab 800

Magnum Opus Lab 2400

range and tweeter. Rated Z: 8. Power: min., 5; max., 150. Response: 26-45,000 Hz. DB gauge circuit breaker. 15¼H x 28W x 13¼D. 70 lbs. \$459.

MARANTZ

Imperial 4G

Acoustic suspension. 8" woofer. 1¼" tweeter. Rated Z: 8. Power: min., 5; max., 15. Response: 60-15,000 Hz ± 5 dB. ref. 100 dB/SPL. 19½H x 11¼W x 8½D. 20 lbs. \$59.95.

Imperial 5G

Ported. 8" woofer. 1¼" tweeter. Controls: 3-position high-frequency level switch. Rated Z: 8. Power: min., 5; max., 15. Response: 45-16,000 Hz ± 5 dB. ref. 100 dB/SPL. 23H x 12W x 9½D. 23½ lbs. \$99.95.

Imperial 7

Ported. 12" woofer. 3½" midrange. 1¼" tweeter. Controls: 3-position midrange and high-frequency level switches. Rated Z: 8. Power: min., 10; max., 50. Response: 35-20,000 Hz ± 5 dB. ref. 100 dB/SPL. 25½H x 14¼W x 11½D. 45 lbs. \$199.95.

Imperial 9

Ported. Two 10" woofers. four 3½" midranges. two 1¼" tweeters. Controls: midrange and high frequency. Rated Z: 8. Power: min., 20; max., 100. Response: 30-18,000 Hz ± 3 dB. ref. 100 dB/SPL. 30½H x 24W x 18D. \$499.95.

Imperial 44

Acoustic suspension. 8" woofer. 3" midrange. 3" tweeter. CF: 2,000 Hz and 8,000 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 45-18,000 Hz ± 3 dB. ref. 90 dB/SPL. 19H x 11¼W x 8½D. \$79.95.

Imperial 55

Acoustic suspension. 8" woofer. 4½" midrange. 1½" dome tweeter. CF: 1,000 Hz and 2,000 Hz. Controls: variable tweeter. Rated Z: 8. Power: min., 5; max., 50. Response: 40-20,000 Hz ± 3 dB. ref. 90 dB/SPL. 23H x 12W x 9½D. \$129.95.

Imperial 66

"Variable acoustic suspension or ported." 10" woofer. 4½" midrange. 1½" dome tweeter. CF: 1,200 Hz and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 75. 24¼H x 14½W x 11D. \$169.95.

Imperial 77

"Variable acoustic suspension or ported." 12" woofer. 4½" midrange. 1½" dome tweeter. 1" super-tweeter. CF: 500 Hz, 2,000 Hz, and 8,000 Hz. Controls: midrange, tweeter, and super-tweeter. Rated Z: 8. Power: min., 20; max., 100. Response: 32-23,000 Hz ± 3 dB. ref. 90 dB/SPL. Removable plug to change the system from acoustic suspension to ported. 25½H x 14¼W x 12¼D. \$259.95.

Imperial 88

Same as Imperial 77 except two 1" super-tweeters. Response: 25-25,000 Hz ± 3 dB. ref. 90 dB/SPL. 41¼H x 16W x 12D. \$349.95.

MICRO/ACOUSTICS

FRM-1

Acoustic suspension. 10" woofer. five 1¼"

breaker. 28H x 15¼W x 13¼D. 65 lbs. \$359.

LAB 33

Acoustic suspension. 10" woofer. 5" midrange. dome tweeter. piezoelectric tweeter. CF: 500 Hz, 2,000 Hz, and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 15; max., 50. Response: 30-45,000 Hz. Circuit breaker. 24H x 14½W x 11D. 48 lbs. \$199.

LAB 800

"Dynamic damping system." Two 10" woofers. 5" midrange. two dome tweeters. two cone tweeters. piezoelectric tweeter. CF: 750 Hz, 3,000 Hz, and 4,000 Hz. Controls: woofer, midrange, and tweeter. Rated Z: 4-8. Power: min., 15; max., 100. Response: 25-45,000 Hz. Circuit breakers. 28H x 15¼W x 13¼D. 68 lbs. \$429.

LAB 1200

"Dynamic damping system." 12" woofer. 10" woofer. 5" midrange. two dome tweeters. six cone tweeters. piezoelectric tweeter. CF: 750 Hz, 3,000 Hz, and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 4. Power: min., 20; max., 100. Response: 20-45,000 Hz. Circuit breaker. 32H x 18W x 18½D. 95 lbs. \$579.

LAB 2400

"Dynamic damping system." Four 12" woofers. four 5" midranges. eight cone tweeters. six dome tweeters. two piezoelectric tweeters.

CF: 750 Hz, 3,000 Hz, and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 4-8. Power: min., 20; max., 200. Response: 20-45,000 Hz. 32H x 36W x 18½D. 180 lbs. \$1,450.

Opus S

Acoustic suspension. 10" woofer. cone tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 12; max., 50. Response: 35-18,000 Hz. 24H x 14½W x 11D. 42 lbs. \$109.95.

Opus 1

Acoustic suspension. 10" woofer. dome tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 12; max., 50. Response: 35-20,000 Hz. 24H x 14½W x 11D. 42 lbs. \$139.95.

Opus 200

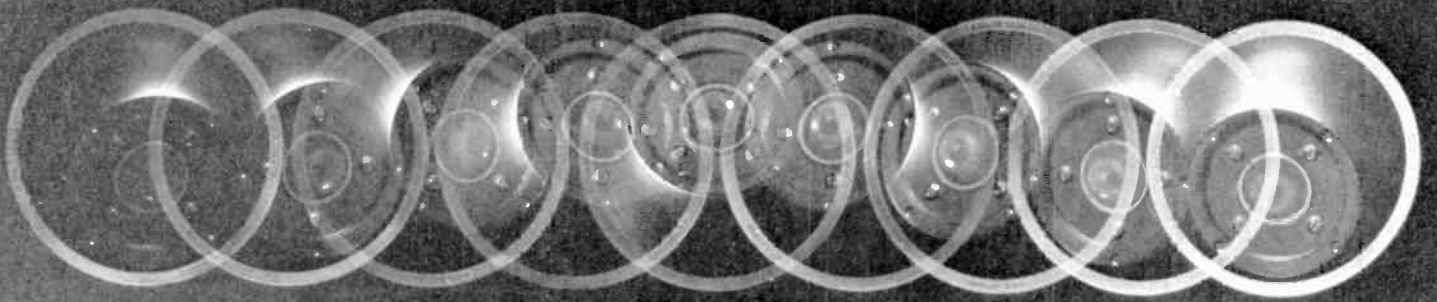
"Dynamic damping system." Two 10" woofers. dome tweeter. CF: 2,000 Hz. Controls: tweeter. Rated Z: 4. Power: min., 8; max., 100. Response: 28-20,000 Hz. Circuit breaker. 24H x 14½W x 11D. 42 lbs. \$189.95.

DB TRON 500

Acoustic suspension. 10" woofer. 3½" phenolic ring tweeter. CF: 3,000 Hz. Rated Z: 8. Response: 35-22,000 Hz. Sound pressure level meter, circuit breaker. 42 lbs. \$139.

Lab Sound Monitor

"Dynamic damping system." Four 10" woofers. 5" midrange. dome tweeter. piezoelectric tweeter. "sound pressure indicator." CF: 500 Hz, 2,000 Hz, and 4,000 Hz. Controls: mid-

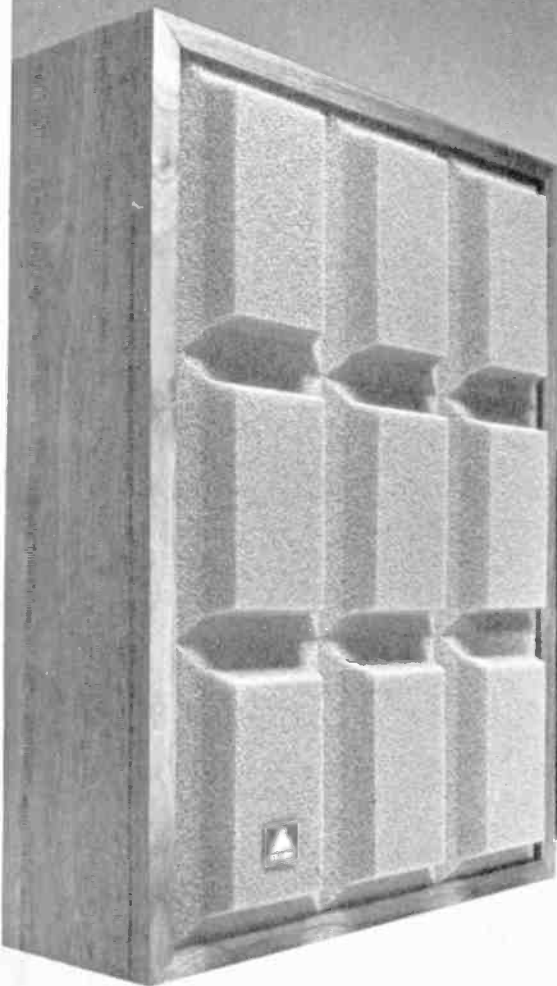


Stark Designs puts its sound where your ears are.

Placement of loudspeakers has a lot to do with how they sound in your home. Try as you may, your listening room just might not be suited to boxes that only know how to pump sound straight out in front.

Stark Designs took note of the problem and did something about it. Three years of research and testing have resulted in development of the Directed Dispersion Concept, an exclusive Stark Designs feature which lets you aim the high frequencies together if the speakers are far apart, apart if the speakers are too close... up, down, or wherever needed to suit you and your room's needs.

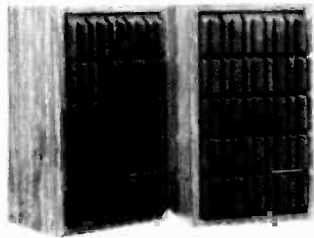
The Directed Dispersion Concept is featured in three 3-way systems, housed in cabinets which many have compared to fine German automobiles for classic beauty and quality of workmanship. As for sound quality—let your ears, not our specs, be the judge.



 **STARK DESIGNS**

12111 BRANFORD STREET, SUN VALLEY, CALIFORNIA 91352 • (213) 896-0556

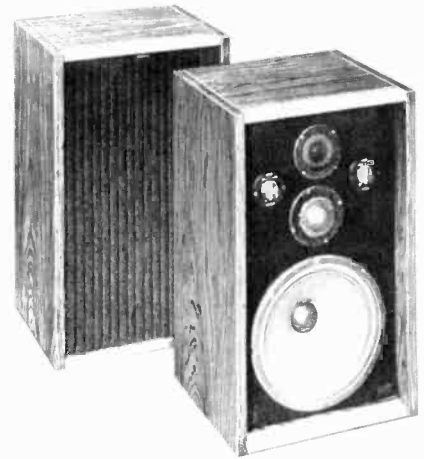
CIRCLE 27 ON READER-SERVICE CARD



Marantz Imperial 44



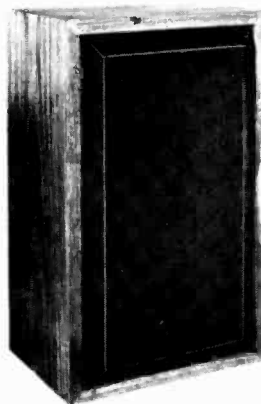
Marantz Imperial 88



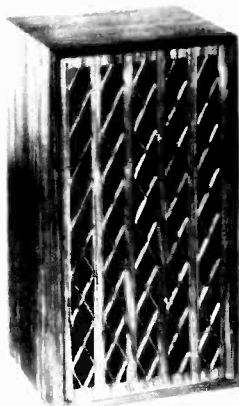
MX 2820



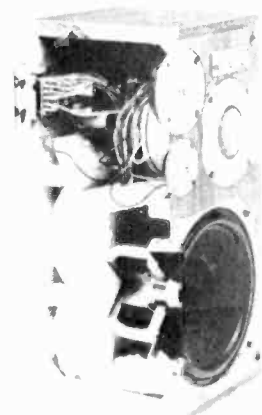
**Norman Labs
Model Nine**



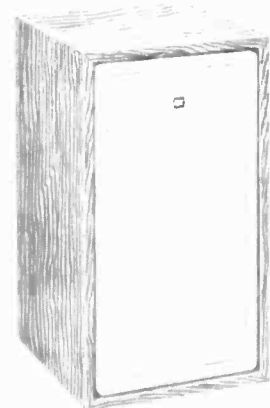
Olson SP-067



Olson SS-175



Mitsubishi DS-303



MX 2760

tweeters. CF: 1,700 Hz. Controls: dispersion and tweeter. Rated Z: 8. Power: min., 20; max., 60. Response: 35-18,000 Hz. Semi-decahedron array; manufacturer claims 180 degree dispersion; optional grille colors (five). 5-yr. warranty. 25 $\frac{1}{2}$ H x 15 $\frac{1}{4}$ W x 12 $\frac{1}{4}$ D. 39 lbs.\$165.

FRM-2

Acoustic suspension. 10" woofer, three 1 $\frac{1}{4}$ " tweeters. CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 10; max., 50. Response: 40-16,000 Hz. Trihedron array; manufacturer claims 160 degree dispersion; optional grille colors (two); 5-yr. warranty. 25 $\frac{1}{2}$ H x 15 $\frac{3}{4}$ W x 12 $\frac{1}{4}$ D. 37 lbs.\$129.

MITSUBISHI

DS-28B

"Hermetically sealed." 10" cone woofer, 4" cone midrange, 1 $\frac{1}{4}$ " dome tweeter. CF: 800 Hz and 5,000 Hz. Controls: 3-position midrange and tweeter switches. Rated Z: 8. Power: min., 20; max., 50. Response: 40-20,000 Hz. ref. 94 dB/SPL at 1 meter. 23 $\frac{1}{2}$ H x 13 $\frac{3}{4}$ W x 10 $\frac{1}{2}$ D. 33 lbs.\$200.

DS-36BR

"Hermetically sealed." 12" cone woofer, 5" cone midrange, 1" dome tweeter. CF: 600 Hz and 5,000 Hz. Controls: 3-position midrange and tweeter switches. Rated Z: 8. Power: min., 20; max., 60. Response: 30-20,000 Hz. ref. 93 dB/SPL at 1 meter. 26 $\frac{1}{2}$ H x 15 $\frac{1}{4}$ W x 11 $\frac{1}{2}$ D. 51 lbs.\$300.

DS-251 Mk II

Acoustic suspension. 10" cone woofer, 2" cone tweeter, 1 $\frac{1}{4}$ " cone super-tweeter. CF: 2,000 Hz and 10,000 Hz. Controls: 2- and 3-way operation switch. Rated Z: 8. Power: min., 20; max., 40. Response: 40-25,000 Hz. ref. 91 dB/SPL at 1 meter. 20 $\frac{3}{4}$ H x 12 $\frac{1}{2}$ W x 9 $\frac{1}{2}$ D. 26 $\frac{1}{2}$ lbs.\$170.

DS-303

Acoustic suspension. 12" cone woofer, 2 $\frac{1}{2}$ " dome midrange, 1" dome tweeter, $\frac{3}{8}$ " dome super-tweeter. CF: 600 Hz, 5,000 Hz, and 10,000 Hz. Controls: midrange, tweeter, and super-tweeter. Rated Z: 6. Power: min., 40; max., 100. Response: 30-35,000 Hz. ref. 90 dB/SPL at 1 meter. 24 $\frac{1}{2}$ H x 14 $\frac{1}{4}$ W x 13D. 75 lbs.\$580.

MX

MX 2760

Air suspension. 10" woofer, 3 $\frac{1}{2}$ " cone tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 10; max., 35. Response: 40-17,000 Hz. 21 $\frac{1}{2}$ H x 12 $\frac{1}{2}$ W x 12D. 29 lbs.\$75.

MX 2770

Air suspension. 12" woofer, 3 $\frac{1}{2}$ " cone tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 10; max., 50. Response: 40-17,000 Hz. 23H x 14 $\frac{3}{4}$ W x 12D. 34 lbs.\$100.

MX 2810

Air suspension. 10" woofer, 2" hemispherical dome midrange, 2" phenolic ring cone tweeter. CF: 1,500 Hz and 4,500 Hz. Controls: 3-position midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 50. Re-

sponse: 30-20,000 Hz. Removable foam grille, finished front-speaker baffle and front-mounted level controls with chrome die-cast knobs, optional base at \$9.95 a pair. 25 $\frac{3}{4}$ H x 23 $\frac{1}{2}$ H x 15 $\frac{1}{4}$ W x 12 $\frac{1}{2}$ D. 35 lbs.\$150.

MX 2820

Air suspension. 12" woofer, 2" hemispherical dome midrange, 2" phenolic ring cone tweeter. CF: 1,500 Hz and 4,500 Hz. Controls: 3-position midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 75. Response: 25-20,000 Hz. Removable foam grille, finished front-speaker baffle and front-mounted level controls with chrome die-cast knobs, optional base at \$9.95 a pair. 25 $\frac{3}{4}$ H x 15 $\frac{1}{4}$ W x 13 $\frac{1}{4}$ D. 40 lbs.\$200.

MX 2830

Air suspension. 15" woofer, 2" hemispherical dome midrange, 2" phenolic ring cone tweeter. CF: 1,500 Hz and 4,500 Hz. Controls: 3-position midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 100. Response: 20-20,000 Hz. Removable foam grille, chrome die-cast level control knobs, optional base at \$9.95 a pair. 29H x 20 $\frac{1}{4}$ W x 15 $\frac{1}{2}$ D. 55 lbs.\$250.

NORMAN LABS

Model Seven

Acoustic suspension. 12" woofer, two 1" dome tweeters. CF: 1,500 Hz. Controls: 3-position tweeter switch. Rated Z: 8. Power: manufacturer claims system will handle output of any amplifier designed for home use. 23 $\frac{1}{2}$ H x 15 $\frac{1}{2}$ W x 12 $\frac{1}{2}$ D. 40 lbs.\$175.

Model Eight

Acoustic suspension. 10" woofer, 1" dome tweeter. CF: 1,500 Hz. Rated Z: 8. Power: manufacturer claims system will handle output of any amplifier designed for home use. 23H x 12W x 9 $\frac{1}{4}$ D. 29 lbs.\$110.

Model Nine

Acoustic suspension. Three 10" woofers, three 1" dome tweeters. CF: 1,500 Hz. Controls: 3-position tweeter switch, 2-position woofer switch. Rated Z: 4. Power: manufacturer claims system will handle output of any amp designed for home use. 45 $\frac{1}{4}$ H x 15 $\frac{1}{2}$ W x 15D. 75 lbs.\$400.

OHM

B+

Acoustic suspension. 12" woofer, 2 $\frac{1}{2}$ " cone tweeter, 1" dome tweeter. CF: 1,800 Hz and 5,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 50; max., 60. Response: 35-20,000 Hz \pm 4 dB. 26H x 15W x 10 $\frac{3}{4}$ D. 50

How Should A Speaker Sound?

The extent to which a speaker produces no sound other than that which it is "ordered" to produce by the amplifier signal is a practical measure of its fidelity or accuracy. This quality is, to some extent, indicated by technical data but the ultimately true test is to listen to the speaker used in a sound playback system.

lbs.\$250.

C+

Acoustic suspension. 10" woofer, 2 $\frac{1}{2}$ " cone tweeter, 1" dome tweeter. CF: 1,800 Hz and 5,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 30; max., 50. Response: 40-20,000 Hz \pm 4 dB. 25H x 14W x 9 $\frac{1}{4}$ D. 40 lbs.\$180.

D

Vented. Two 10" woofers, 2" cone tweeter. CF: 1,700 Hz. Controls: tweeter. Rated Z: 8. Power: min., 20; max., 50. Response: 50-1,600 Hz \pm 4 dB. 25H x 14W x 8D. 35 lbs.\$120.

E

Acoustic suspension. Two 6" woofers, two 2" tweeters. CF: 1,700 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 35. Response: 52-1,600 Hz \pm 4 dB. 21 $\frac{1}{2}$ H x 11 $\frac{1}{2}$ W x 7 $\frac{1}{4}$ D. 20 lbs.\$90, walnut: \$50, vinyl.

F

Infinite baffle. 12" Walsh coherent transmission line diaphragm. Rated Z: 4-8. Power: min., 50; max., 125. Response: 33-20,000 Hz \pm 4 dB. 43 $\frac{1}{2}$ H x 17 $\frac{3}{4}$ W&D bottom, 13 $\frac{1}{2}$ W&D top. 75 lbs.\$500, walnut: \$550, teak: \$600, rosewood.

G

Vented system with passive radiator. 10" passive radiator (vent substitute), 8" Walsh transmission line cone. Rated Z: 8. Power: min., 40; max., 155. Response: 32-19,500 Hz \pm 4 dB. 35H x 12 $\frac{1}{2}$ W x 11 $\frac{1}{2}$ D. 45 lbs.\$350.

H

Vented system with passive radiator. 8" woofer, 12" passive radiator, 2 $\frac{1}{2}$ " cone tweeter, 1" dome tweeter. CF: 1,800 Hz and 5,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 40; max., 60. Response: 32-20,000 Hz \pm 4 dB. 26H x 15W x 10 $\frac{1}{4}$ D. 52 lbs. Price not available.

OLSON

SP-067 "Acoust/Air"

Acoustic suspension. 8" woofer, 2 $\frac{1}{4}$ " midrange/tweeter. CF: 1,600 Hz. Rated Z: 8. Power: min., 5; max., 20. Response: 60-20,000 Hz \pm 5 dB. 19H x 10W x 9D. 20 lbs.\$69.98.

SP-068 "Acoust/Air"

Acoustic suspension. 10" woofer, 4" midrange, 2 $\frac{1}{4}$ " dome tweeter. CF: 800 Hz and 5,000 Hz. Rated Z: 8. Power: min., 5; max., 30. Response: 40-20,000 Hz \pm 5 dB. 24H x 13 $\frac{1}{2}$ W x 11 $\frac{1}{2}$ D. 38 lbs.\$99.98.

SP-069 "Acoust/Air"

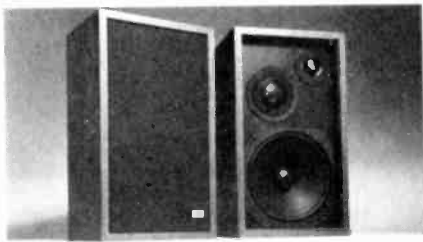
Acoustic suspension. 12" woofer, 4" midrange, 2 $\frac{1}{4}$ " super-tweeter. CF: 800 Hz and 5,000 Hz. Rated Z: 8. Power: min., 5; max., 40. Response: 25-25,000 Hz \pm 5 dB. 25H x 14W x 11 $\frac{1}{2}$ D. 48 lbs.\$129.98.

SS-175 "X-Air III"

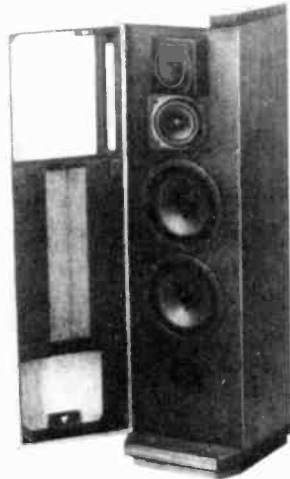
Acoustic suspension. 12" woofer, 5" midrange, 2 $\frac{1}{2}$ " tweeter, 1 $\frac{1}{2}$ " super-tweeter. Rated Z: 8. Power: min., 5; max., 50. Response: 40-20,000 Hz \pm 5 dB. 25 $\frac{1}{2}$ H x 11 $\frac{1}{2}$ W x 11 $\frac{1}{4}$ D. 40 lbs.\$119.98.

SS-177 "Olson-Aire 1"

Acoustic suspension. Six 6" full range, 2 $\frac{1}{2}$ "



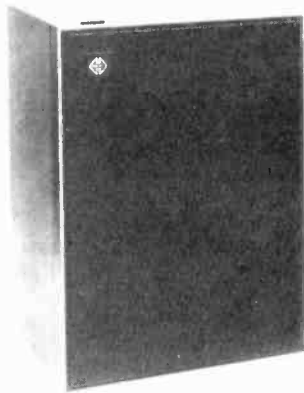
Onkyo Model 20



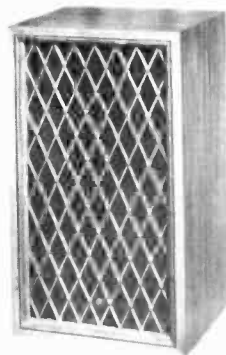
Onkyo Radian III



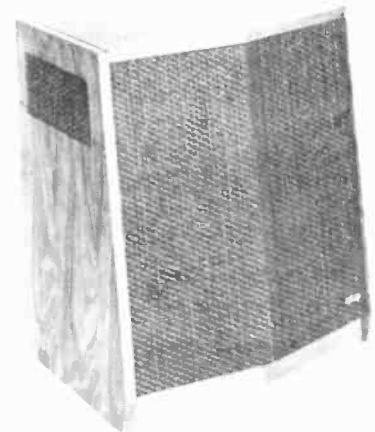
Ortofon 335



Philips RH-532



Pioneer High Fidelity CS-66G



Pioneer High Fidelity HPM-200

tweeter. Rated Z: 8. Power: min., 3; max., 25. Response: 50-18,000 Hz. \pm 5 dB. 24 $\frac{1}{2}$ "H x 15 $\frac{1}{2}$ "W x 12"D. 30 lbs.\$74.95.

ONKYO

Model 8

Ported bass reflex. 8" woofer, 2" cone tweeter. CF: 6,000 Hz. Controls: 3-position tweeter switch. Rated Z: 8. Power: min., 10; max., 30. Response: 35-20,000 Hz. 21 $\frac{1}{8}$ "H x 11 $\frac{1}{8}$ "W x 9 $\frac{3}{4}$ "D. 16 lbs.\$89.95.

Model 12

Ported bass reflex. 10" woofer, 3" cone tweeter. CF: 2,500 Hz. Controls: 3-position tweeter switch. Rated Z: 8. Power: min., 10; max., 40. Response: 33-20,000 Hz. 23 $\frac{1}{4}$ "H x 13 $\frac{1}{2}$ "W x 11 $\frac{1}{8}$ "D. 34 lbs.\$129.95.

Model 20

Acoustic suspension. 12" woofer, 2" dome midrange, 1" dome tweeter. CF: 700 Hz and 7,000 Hz. Controls: 5-position midrange and tweeter switches. Rated Z: 8. Power: min., 10; max., 50. Response: 35-20,000 Hz. 23 $\frac{3}{4}$ "H x 13 $\frac{1}{2}$ "W x 11 $\frac{1}{8}$ "D. 40 lbs.\$199.95.

Model 25A

Acoustic suspension. 14" woofer, 2" dome midrange, 1" dome tweeter. CF: 700 Hz and 7,000 Hz. Controls: 5-position midrange and tweeter switches. Rated Z: 8. Power: min., 10; max., 60. Response: 30-20,000 Hz. 25 $\frac{1}{2}$ "H x 14 $\frac{1}{4}$ "W x 11 $\frac{1}{8}$ "D. 54 $\frac{1}{2}$ lbs.\$249.95.

Model 30

Acoustic suspension. 12" woofer, 3 $\frac{1}{2}$ " x 10 $\frac{1}{2}$ " horn midrange, 2 $\frac{1}{4}$ " horn tweeter. CF: 700 Hz

and 5,000 Hz. Controls: 5-position midrange and tweeter switches. Rated Z: 8. Power: min., 10; max., 60. Response: 20-20,000 Hz. 28 $\frac{1}{2}$ "H x 16 $\frac{1}{2}$ "W x 15 $\frac{1}{8}$ "D. 51 lbs.\$299.95.

Radian III

Ported bass reflex. Two 6 $\frac{1}{2}$ " cone woofers, two 3" cone tweeters. CF: 1,500 Hz. Controls: tweeter. Rated Z: 8. Power: min., 10; max., 30. Response: 60-20,000 Hz. Manufacturer claims 180 degree dispersion. 33 $\frac{1}{2}$ "H x 9 $\frac{1}{2}$ "W x 11 $\frac{1}{8}$ "D. 29 lbs.\$119.95.

ORTOFON

225

"Electro-Dynamic type with acoustic flow resistance." 10" woofer, dome tweeter. CF:

1,800 Hz. Rated Z: 8. Power: min., 15; max., 45. 21H x 11½W x 9¾D. 25 lbs. walnut, \$139; rosewood, \$149.

335

"Electro-Dynamic type with acoustic flow resistance" 10" woofer, 5" cone midrange, dome super-tweeter. CF: 600 Hz and 5,000 Hz. Controls: 5-position midrange attenuator switch. Rated Z: 8. Power: min., 20; max., 50. 23¾H x 13W x 9¾D. 33 lbs. walnut, \$199; rosewood, \$214.

445

"Electro-dynamic type with acoustic flow resistance." Two 8½" non-identical woofers, 5" cone midrange, dome super-tweeter. CF: 100 Hz, 500 Hz, and 5,000 Hz. Controls: 5-position midrange attenuator switch. Rated Z: 8. Power: min., 25; max., 90. 27H x 15W x 9¾D. 42 lbs. walnut, \$330; rose, \$350.

PHILIPS

RH-532

Motional feedback system including internal bi-amplification, 8" motional feedback woofer, 5" cone midrange, 1" dome tweeter. CF: electronic, 500 Hz; passive, 4,000 Hz. Controls: input sensitivity, 3-position switch, on/off switch, left and right selector switch. Rated Z: preamp input, 3,000; power amp input, 25. Power: built-in low-frequency amp, 40 watts; bandwidth, 35 Hz-1,000 Hz; THD, 0.2%; Load Z, 4. Built-in high-frequency amp, 20 watts; bandwidth, 400 to 20,000; THD, 0.2%; Load Z, 8. Response: 35-20,000. 15H x 11¼W x 8½D. 26 lbs. \$365.

PIONEER HIGH FIDELITY

CS-44G

Acoustic suspension, 8" woofer, 2½" cone tweeter. CF: 3,200 Hz. Rated Z: 8. Power: min., 15; max., 25. Response: 35-20,000 Hz. 18H x 11W x 10D. 19 lbs. \$79.95.

CS-63DX

Acoustic suspension, 15" woofer, two 5" midranges, horn tweeter, two horn super-tweeters. CF: 770 Hz, 3,300 Hz, and 12,000 Hz. Rated Z: 8. Power: min., 10; max., 80. Response: 20-22,000 Hz. 28½H x 19W x 13D. 63 lbs. \$279.95.

CS-66G

Acoustic suspension, 10" woofer, 6½" midrange, 3" cone tweeter. CF: 1,850 Hz and 6,850 Hz. Controls: 3-position tweeter switch. Rated Z: 8. Power: min., 10; max., 40. Response: 35-20,000 Hz. 22H x 12W x 11½D. 29 lbs. \$119.95.

CS-99A

Acoustic suspension, 15" woofer, 5" midrange, 4" midrange, "multicellular" horn

tweeter, two ½" dome super-tweeters. CF: 800 Hz, 2,000 Hz, 5,000 Hz, and 10,000 Hz. Rated Z: 8. Power: min., 10; max., 100. Response: 25-22,000 Hz. 25H x 16W x 11D. 51¼ lbs. \$239.95.

CS-500G

Acoustic suspension, 10" woofer, 5" midrange, horn tweeter. CF: 800 Hz and 6,000 Hz. Controls: midrange and tweeter. Power: min., 10; max., 50. Response: 40-20,000 Hz. Can be bi- or tri-amplified. 22H x 13W x 12D. 38¼ lbs. \$149.95.

CS-700G

Acoustic suspension, 12" woofer, 4¾" cone midrange, "multicellular" horn tweeter. CF: 500 Hz and 4,500 Hz. Controls: midrange and

tweeter. Rated Z: 8. Power: min., 10; max., 60. Response: 35-20,000 Hz. Can be bi- or tri-amplified. 26H x 15W x 12D. 37 lbs. \$199.95.

HPM-200

Acoustic suspension. Two 10" woofers, 2½" soft dome midrange, high polymer tweeter, high polymer super-tweeter. CF: 120 Hz, 700 Hz, 2,000 Hz, and 5,000 Hz. Rated Z: 6. Power: min., 15; max., 200. Response: 25-25,000 Hz. 32H x 29W x 19D. 124 lbs. \$499.95.

Project 60A

Bass reflex, 8" woofer, 1¾" cone tweeter. CF: 5,000 Hz. Rated Z: 8. Power: min., 5; max., 20. Response: 50-20,000 Hz. Wall mountable. 18½H x 10½W x 8½D. 13 lbs. \$79.95.

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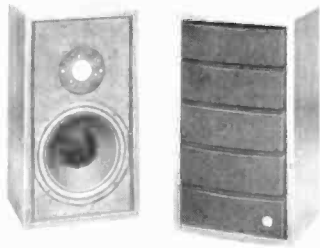
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Understanding the Numbers

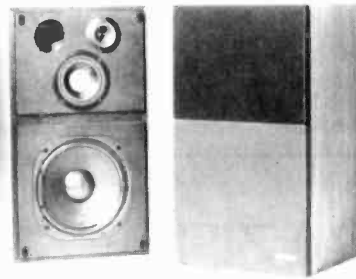
For detailed explanations of the technical "shorthand" used in the equipment directory, the reader is invited to study the articles in this volume, especially those dealing with how speakers work, and how they are evaluated.

CIRCLE 13 ON READER-SERVICE CARD



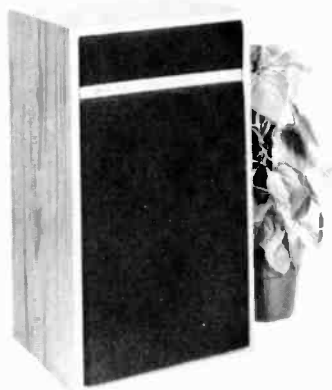
Pioneer High Fidelity Project 80

Pioneer High Fidelity R-500B



Quadraflex RS-4

Polk Audio Model 9a



Controls: tweeter. Rated Z: 8. Power: min., 10; max., 75. Response: 35-20,000 Hz. 26H x 15W x 13½D. 50½ lbs.\$249.95.

POLK AUDIO

Model Seven

Auxiliary passive bass radiator. Two 5½" woofers/midrange, 8" bass radiator, 1" soft dome tweeter. CF: 150 Hz and 5,000 Hz. Rated Z: 4. Power: min., 5; max., 60. Response: 45-25,000 Hz ± 2.5 dB. 19H x 12W x 8½D. 36 lbs.\$125.

Model 9a

Auxiliary passive bass radiator. Four 4½" "extended range," 8" bass radiator, 1" soft dome tweeter. CF: 150 Hz and 5,000 Hz. Rated Z: 8. Power: min., 5; max., 100. Response: 48-27,000 Hz ± 2 dB. 33½H x 10½W x 9D. 40 lbs.\$165.

QUAD

Quad Electrostatic

Full range electrostatic. Rated Z: 16. Power: min., 15; max., 35. 31H x 34½W x 10½D. 39 lbs.\$425.

QUADRAFLEX

RS-3

Acoustic suspension, 8" woofer, 3" tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 10; max., 20. Response: 60-20,000 Hz ± 5 dB. 21¼H x 12¾W x 8D. 25 lbs.\$59.95.

RS-4

Acoustic suspension, 10" woofer, 3" tweeter. CF: 1,500 Hz. Rated Z: 4. Power: min., 10; max., 25. Response: 55-20,000 Hz ± 5 dB. 23½H x 13¾W x 11D. 30 lbs.\$89.95.

RS-5

Acoustic suspension, 10" woofer, 4½" midrange, 3" tweeter. CF: 650 Hz and 6,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 25. Response: 45-20,000 Hz ± 5 dB. 24¾H x 14¾W x 11¾D. 40 lbs.\$129.95.

RS-6

Acoustic suspension, 12" woofer, 6" midrange, 1¾" tweeter. CF: 400 Hz and 3,000 Hz. Controls: midrange and tweeter. Power: min., 8; max., 40. Response: 40-18,000 Hz ± 5 dB. 26½H x 15¾W x 12½D. 46 lbs.\$179.95.

QUIET SOUND

Model 223

Air suspension, 10" woofer, 1¾" tweeter. CF: 1,800 Hz. Controls: continuously variable high frequency. Rated Z: 8. Power: min., 11; max., 100. Response: 35-18,000 Hz ± 4.5 dB. Optional grille colors, 5-yr. warranty, 25½H x 11W x 14½D.\$99.95.

Nubian I

Air suspension, 15" woofer, two 2½" cone midranges, two 1¾" tweeters. CF: 500 Hz and 5,000 Hz. Controls: continuously variable mid and high frequencies. Rated Z: 8. Power: min., 20; max., 150. Response: 29-18,000 Hz ± 3.5 dB. Fuse protection, 5-yr. warranty, 28H x 13W x 18D.\$199.95.

Project 80

10" woofer, 1½" soft dome tweeter. CF: 700 Hz. Rated Z: 8. Power: min., 15; max., 30. Response: 35-20,000 Hz. 21H x 12W x 11D. 25 lbs.\$99.95.

Project 100

Acoustic suspension, 10" woofer, 1½" dome tweeter. CF: 700 Hz. Rated Z: 8. Power: min., 15; max., 35. Response: 30-20,000 Hz. 23H x 13W x 10½D. 40 lbs.\$129.95.

R-300

Bass reflex, 10" woofer, horn tweeter. CF:

4,200 Hz. Rated Z: 8. Power: min., 10; max., 40. Response: 45-20,000 Hz. 23H x 13W x 11D. 26½ lbs.\$119.95.

R-500B

Bass reflex, 10" woofer, 5" cone midrange, horn tweeter. CF: 650 Hz and 6,000 Hz. Rated Z: 8. Power: min., 10; max., 60. Response: 35-20,000 Hz. 24H x 14W x 12D. 38½ lbs.\$169.95.

R-700

Bass reflex, 12" woofer, horn midrange, "multicellular" tweeter. CF: 700 Hz and 14,000 Hz.

Nubian II

Similar to Model 223, except has a 1 1/2" mylar dome tweeter.

Nubian III

Air suspension, 8" woofer, 1 1/4" tweeter, CF: 2,200 Hz. Controls: continuously variable high frequency. Rated Z: 8. Power: min., 9; max., 60. Response: 42 18,000 Hz ± 5 dB. Fuse protection, 5-yr. warranty, 21 1/2"H x 13"W x 8 1/2"D. \$59.95.

Nubian IV

Air suspension, 10" woofer, 1 1/2" dome midrange, 1 1/4" tweeter, CF: 1,000 Hz and 5,000 Hz. Controls: continuously variable mid and high frequencies. Rated Z: 8. Power: min., 15; max., 100. Response: 35 18,000 Hz ± 4.5 dB. Fuse protection, 5-yr. warranty, 25 1/2"H x 11"W x 14 1/2"D. \$125.

Nubian V

Air suspension, 12" woofer, 4 1/2" midrange, 1 1/4" tweeter, 1" mylar dome tweeter, CF: 800 Hz and 4,000 Hz. Controls: continuously variable mid and high frequencies. Rated Z: 8. Power: min., 20; max., 110. Response: 34 18,000 Hz ± 3.5 dB. Fuse protection, 5-yr. warranty, 25 1/2"H x 12 1/4"W x 15"D. \$135.

Nubian VI

Bass reflex, 12" woofer, 4 1/2" midrange, 1 1/4" tweeter, CF: 1,200 Hz and 5,000 Hz. Controls: mid and high frequencies. Rated Z: 8. Power: min., 10; max., 60. Response: 44 18,000 Hz ± 5 dB. Fuse protection, optional grille colors, 5-yr. warranty, 25 1/4"H x 14"W x 12"D. \$110.

QSS I

Air suspension tower with an acoustic coupler. Two 10" woofers, four 4 1/2" midranges, four 1 1/4" tweeters, CF: 400 Hz and 4,000 Hz. Controls: continuously variable mid and high frequencies. Rated Z: 8. Power: min., 30; max., 150. Response: 20 18,000 Hz ± 5 dB. Fuse protection, 5-yr. warranty; manufacturer claims 240-degree dispersion, 38"H x 24"W x 14"D. \$299.95.

REALISTIC

Mach One

Acoustic suspension. Rated Z: 8. \$199.50.

MC-500

Acoustic suspension, 5" woofer, 2" tweeter. Rated Z: 8. Response: 40 20,000 Hz. 5-yr. guarantee, 11 1/4"H x 9 1/4"W x 5 1/2"D. \$39.95.

MC-1000

Acoustic suspension, 8" woofer, 3" tweeter. Rated Z: 8. Response: 30 20,000 Hz. 5-yr. guarantee, 17 1/4"H x 8 1/4"W x 11 1/4"D. \$59.95.

A Note on Prices

Prices shown in these pages are manufacturers' or importers' suggested retail prices, updated as is feasible by press time. They may be subject to variation in different locales and to discounts among different retailers. However, most established audio dealers advise that the less discount offered, the more the buyer can expect in the way of consultation, advice, and service.

MC-1500

Acoustic suspension, 8" woofer, 3" tweeter. Rated Z: 8. Response: 40 20,000 Hz. 23 1/2"H x 13 1/4"W x 8 1/4"D. 26 lbs. \$79.50.

Minimus 0.5

Acoustic suspension, 4" full range. Rated Z: 8. Power: max., 10. Response: 100 15,000 Hz. Lifetime guarantee, 4 1/4"H x 6 1/2"W x 4 1/2"D. \$12.95.

Nova-7B

Acoustic suspension, 10" woofer, two 3" tweeters. Controls: tweeter. Rated Z: 8. Response: 20 20,000 Hz. Lifetime guarantee, 22 1/8"H x 12 7/16"W x 11 1/8"D. 34 lbs. \$119.50.

Nova-8B

Acoustic suspension, 12" woofer, two 3" midranges, 3" tweeter. Controls: midrange and tweeter. Rated Z: 8. Response: 20 20,000 Hz. Lifetime guarantee, 25"H x 14"W x 11 1/2"D. 38 lbs. \$139.50.

Optimus-1B

Acoustic suspension, 10" woofer, two 3" tweeters. Controls: tweeter. Rated Z: 8. Response: 20 20,000 Hz. Lifetime guarantee, 23"H x 12"W x 11 1/4"D. 33 lbs. \$89.95.

Optimus-2B

Acoustic suspension, 8" woofer, 3" tweeter. Controls: tweeter. Rated Z: 8. Response: 30 20,000 Hz. Lifetime guarantee, 20"H x 11"W x 10"D. 21 lbs. \$69.95.

Optimus-5B

Acoustic suspension, 12" woofer, two 3" midranges, 3" tweeter. Controls: midrange and tweeter. Rated Z: 8. Response: 20 20,000 Hz. Lifetime guarantee, 25"H x 14"W x 11 1/2"D. 36 lbs. \$114.50.

Solo-1

Acoustic suspension, 8" full range. Rated Z: 8. Response: 50 14,000 Hz. 14 1/2"H x 11"W x 10 1/2"D. \$29.95.

Solo-2

Acoustic suspension, 4" full range. Rated Z: 8. Response: 30 17,000 Hz. 9 1/4"H x 6"W x 7"D. \$24.95.

Solo-4B

Acoustic suspension. Rated Z: 8. 6 1/2"H x 15 1/4"W x 7 1/2"D. \$19.95.

Solo-5

Acoustic suspension, 5" full range. Rated Z: 8. 10"H x 8 1/2"W x 5 1/2"D. \$10.95.

RECTILINEAR

Mini III

Acoustic suspension, 8" woofer, 5" midrange, 2" tweeter, CF: 400 Hz. and 8,000 Hz. Controls: midrange and tweeter. Rated Z: 4. Power: min., 20; max., 75. Response: 50 18,500 Hz ± 4 dB. 12"H x 19"W x 9 1/2"D. 27 lbs. \$109.

IIIa

Ducted port, 12" woofer, 5" midrange, two 2 1/2" tweeters, two 2" super-tweeters, CF: 400 Hz, 5,000 Hz, and 11,000 Hz. Rated Z: 8.

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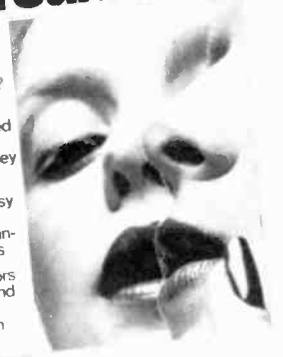
Pentax Goes Bayonet With Three New 35MM's
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DJ58

Power: min., 30; max., 100. Response: 32-18,500 Hz \pm 2 dB. Fuse protection. 35H x 18W x 12D. 75 lbs.\$279.

Model 5

Acoustic suspension. 12" woofer, 7" midrange, 1 1/2" dome tweeter, 1" dome super-tweeter. CF: 200 Hz, 1,800 Hz, and 10,000 Hz. Power: min., 30; max., 250. Response: 32-20,000 Hz \pm 2 dB. Fuse protection. 25H x 15W x 14 1/2D. 72 lbs.\$299; \$319 with base.

Model 7

Ducted port. 12" woofer, 7" midrange, two 1 1/2" dome tweeters, two 1" dome super-tweeters. CF: 200 Hz, 1,800 Hz, and 10,000 Hz. Rated Z: 6. Power: min., 30; max., 350. Response: 32-20,000 Hz \pm 2 dB. Fuse protection. 35H x 18W x 12D. 80 lbs.\$399.

X1b

Ducted port. 10" woofer, 3 1/2" tweeter. CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 10; max., 50. Response: 45-18,500 Hz \pm 2 dB. 23H x 12W x 10D. 32 lbs.\$99.

XII

Ducted port. 10" woofer, 5" midrange, 2 1/2" tweeter. CF: 350 Hz and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 50. Response: 45-18,500 Hz \pm 2 dB. 25H x 14W x 10 1/4D. 42 lbs.\$159.

ROGERSOUND

Alpa Column

Bass reflex. 8" woofer, 3" tweeter. CF: 1,600 Hz. Controls: tweeter. Rated Z: 8. Power: min., 5; max., 50. Response: 45-20,000 Hz. Fuse protected. 48 inches high x 11 inches square. 50 lbs.\$125.

Max

Bass reflex. 12" woofer, 5" midrange, two 3" tweeters. CF: 800 Hz and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 12; max., 75+. Response: 30-20,000 Hz \pm 3.5 dB. Fuse protected. 32H x 18W x 12D. 60 lbs.\$279.95.

Max Tower

Bass reflex. 12" woofer, 8" midrange, two diaphragm cone tweeters. CF: 125 Hz and 4,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 45; max., 75+. Response: 25-20,000 Hz \pm 3 dB. Fuse protected. 48H x 18W x 12D. 85 lbs.utility, \$329.95; walnut, \$399.95.

Mini Monitor

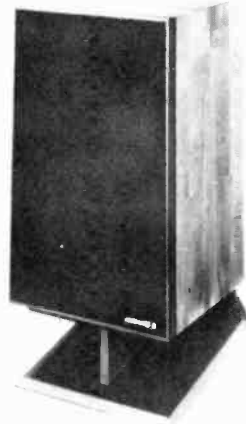
Bass reflex. 8" woofer, 3" tweeter. CF: 1,600 Hz. Controls: tweeter. Rated Z: 8. Power: min., 5; max., 40. Response: 45-20,000 Hz. Fuse protected. 22H x 12 1/8W x 10 1/4D. 29 lbs.\$99.95.

Ranger

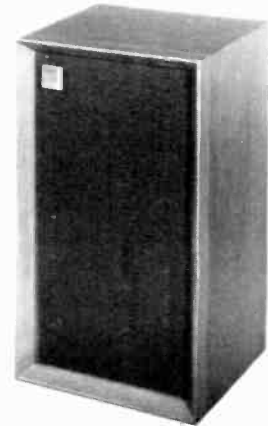
Bass reflex. 10" woofer, 5" midrange, 3" tweeter. CF: 800 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 6; max., 50. Response: 50-20,000 Hz \pm 3 dB. Fuse protected. 25H x 14 1/2W x 12D. 39 lbs.\$149.95.

3300 Studio Monitor

Bass reflex. 12" woofer, 5" midrange, 3" tweeter. CF: 800 Hz and 5,000 Hz. Controls: mid-



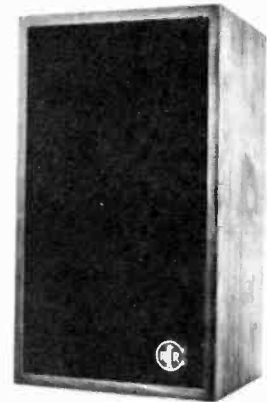
Rectilinear Model 5



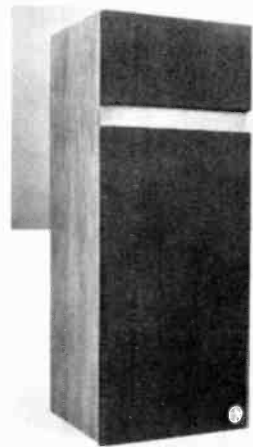
Romex Vega RV-25



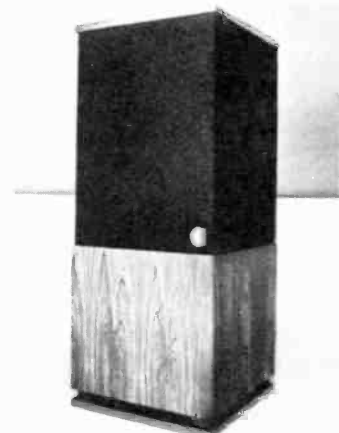
Romex Vega RV-47



RTR EXP-8



RTR HPR-12 Magnum



RTR 280 DR

range and tweeter. Rated Z: 8. Power: min., 6; max., 75. Response: 40-20,000 Hz \pm 1.5 dB. Fuse protected, sculptured grille. 25H x 14½W x 12D. 45 lbs. Walnut. \$209.95; utility, \$189.95; professional, \$229.95.

ROMEX VEGA

RV-8

Ported, tuned duct reflex. 8½" low frequency, 4" mid-high frequency. CF: 1,750 Hz. Controls: 2-way high frequency. Rated Z: 8. Power: max., 25. 13¾H x 13¾W x 9½D. 15½ lbs. \$219.50 per pair.

RV-11

Ported, tuned duct reflex. 8½" low frequency, 4" mid-high frequency. CF: 1,750 Hz. Controls: 2-way high frequency. Rated Z: 8. Power: max., 25. 14¾H x 13¾W x 9½D. 15½ lbs. \$219.50 per pair.

RV-25

Ported, tuned duct reflex. 10" low frequency, 6" mid frequency, 4" high frequency. CF: 1,750 and 7,000 Hz. Controls: separate high frequency and mid frequency. Rated Z: 8. Power: max., 50. Removable grilles. 23¾H x 13¾W x 13¾D. 35 lbs. \$199.50.

RV-27

Similar to model RV-25.

RV-45

Ported, tuned duct reflex. 12" low frequency, 6" mid frequency, two 4" high frequency. CF: 875 Hz and 7,000 Hz. Controls: separate mid and high frequency. Rated Z: 8. Power: max., 100. 26H x 21¾W x 12¾D. 50 lbs. \$299.50.

RV-47

Similar to RV-45.

RTR

EXP-8

Acoustic suspension. 8" woofer, 3¼" tweeter. CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 20; max., 60. Response: 40-20,000 Hz \pm 3 dB. Circuit breaker. 11¼H x 19¾W x 8½D. 25 lbs. \$89.95.

EXP-10

Acoustic suspension. 10" woofer, 3¼" tweeter. CF: 1,200 Hz. Controls: tweeter. Rated Z: 8. Power: min., 30; max., 80. Response: 30-20,000 Hz \pm 3 dB. 14¾H x 25½W x 11½D. 42 lbs. \$124.95.

EXP-12

Acoustic suspension. 12" woofer, 3¼" tweeter. CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 20; max., 80. Response: 32-20,000 Hz \pm 3 dB. Circuit Breaker. 14¾H x 25½W x 11½D. 44 lbs. \$139.95.

How Should A Speaker Sound?

The extent to which a speaker produces no sound other than that which it is "ordered" to produce by the amplifier signal is a practical measure of its fidelity or accuracy. This quality is, to some extent, indicated by technical data but the ultimately true test is to listen to the speaker used in a sound playback system.

ESR-6 "Add-on tweeter"

Bi-polar electrostatic. Six HF-50 elements. CF: 1,500 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 60. Response: 1,500-30,000 Hz \pm 3 dB. Circuit breaker. 14½H x 14½W x 12D. 23 lbs. \$179.95.

ESR-15

Bi-polar electrostatic. Fifteen HF-50 elements. CF: 1,200 Hz. Controls: tweeter. Rated Z: 8. Power: min., 15; max., 100. Response: 1,200-30,000 Hz \pm 3 dB. Add-on tweeter array to be used with any separate midrange-bass or woofer. Circuit breaker. 16½H x 19½W x 16½D. 48 lbs. \$299.95.

HPR-12 Magnum

Hemholz radiator. 12" woofer, 12" passive radiator, 5" midrange, 3" piezoelectric tweeter. CF: 1,500 Hz and 7,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 15; max., 100. Response: 30-25,000 Hz \pm 3 dB. Circuit breaker. 14½H x 36W x 13D. 72 lbs. \$249.95.

180

Column. Two 10" woofers, four 2½" tweeters. CF: 3,000 Hz. Controls: tweeter, bi-amp switch; Tweeter fuse protection. 14H x 33¼W x 14D. 65 lbs. \$239.95.

280 DR

Column. Four 10" woofers, five 2½" midrange/tweeters, piezoelectric super-tweeter. CF: 2,500 Hz and 7,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 25; max., 100. Response: 22-25,000 Hz \pm 3 dB. Circuit breaker. 16½H x 39W x 16½D. 95 lbs. \$349.95.

2500 Studio Master

Bass Reflex. 25" woofer. CF: 2,500 Hz and 7,500 Hz. Controls: midrange and tweeter. Rated Z: 6. Power: min., 25; max., 150. Response: 15-35,000 Hz \pm 3 dB. Circuit breaker. 28H x 59W x 23D. 300 lbs. \$1,165.

SAE

Mark X

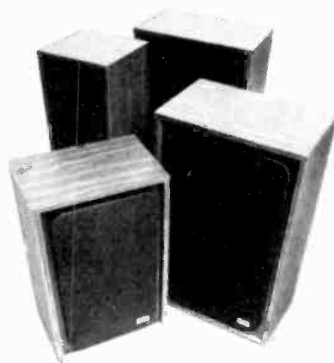
Ducted port. 12" woofer, 5" midrange, two 3" tweeters. CF: 480 Hz, 480-1,440 Hz (level control), 1,440 Hz and up (level control). Controls: midrange and tweeter. Rated Z: 8. Power: min., 20; max., 200. Fuse protection, one tweeter mounted in rear. 25H x 14½W x 12D. 98 lbs. per pair. \$400 per pair.

Mark XI

Ducted port. 12" woofer, two 5" midranges, four 3" tweeters. CF: Low, 120 Hz, 240 Hz, and 480 Hz (switchable); mid, 480-1,440 Hz (level control); high, 1,440 Hz and up (level control). Controls: woofer, midrange, and tweeter. Rated Z: 4. Power: min., 30; max., 300. Fuse protected, two tweeters rear mounted. 27H x 17W x 12¾D. 110 lbs. per pair. \$550 per pair.

Mark XIV

Acoustic suspension/electrostatic. 12" woofer, two 5" midranges, six electrostatic screens (radiate front and rear). CF: low, 120 Hz, 240 Hz, 480 Hz (switchable); mid, 480-1,440 Hz (level control); high, 1,440 Hz and up (level control). Controls: woofer, midrange, and tweeter. Rated Z: 8. Power: min., 100; max., "unlimited." Fuse protected. 42¾H



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Avid 100.

"Extremely smooth and neutral..." Len Feldman, FM Guide—December, 1974/
Avid 102.

"Utter smoothness and freedom from undue emphasis or coloration..." Julian Hirsch, Stereo Review—April, 1974/
Avid 103.

"One of the more sensational high-fidelity buys of our time..." Modern Hi-Fi & Stereo Guide—November, 1974/
Avid 60.

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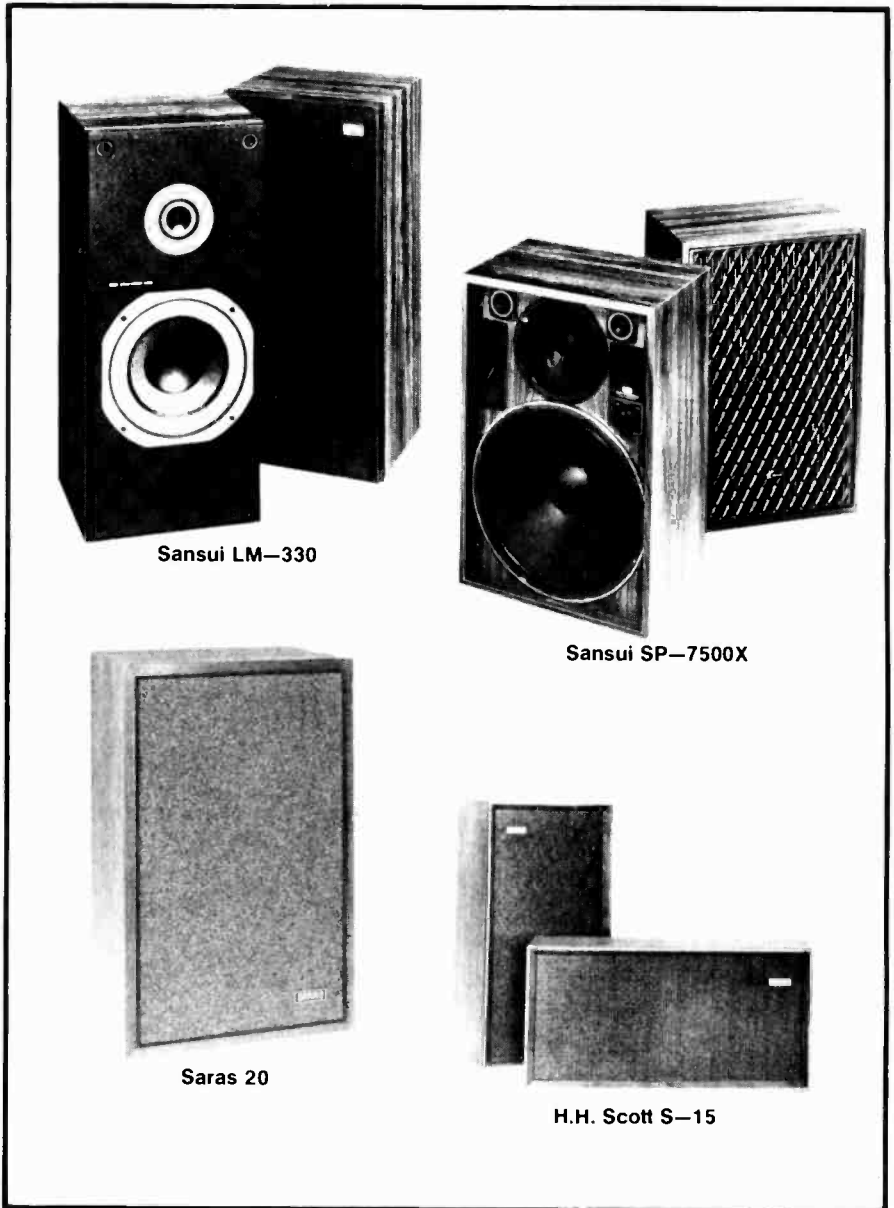
AVID
CORPORATION

10 Tripps Lane/East Providence, R.I. 02914

CIRCLE 4 ON READER-SERVICE CARD

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Sansui LM-330

Sansui SP-7500X

Saras 20

H.H. Scott S-15

x 24W x 18D, 250 lbs. per pair. \$1,800 per pair, walnut; \$2,000 per pair, rosewood.

SANSUI

LM-110
CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: max., 35. Response: 38-20,000 Hz. This is a linear motion drive system. 21 1/16H x 9 13/16W x 7 4/16D, 17 lbs. Price not available.

LM-220
"Linear motion drive system." CF: 2,000 Hz. Controls: tweeter. Rated Z: 8. Power: max., 45. Response: 32-20,000 Hz. 24 7/16H x 11W x 9 1/8D, 26 1/2 lbs. Price not available.

LM-330
"Linear motion drive system." CF: 1,500 Hz. Controls: tweeter. Rated Z: 8. Power: max., 60. Response: 31-20,000 Hz. 28H x 12 1/4W x 12D, 41 1/5 lbs. Price not available.

SP-2500X
CF: 1,200 Hz and 5,000 Hz. Controls: mid-

range and tweeter. Rated Z: 8. Power: max., 100. Response: 30-20,000 Hz. 24 15/16H x 15 1/2W x 11 1/16D, 40 1/2 lbs. Price not available.

SP-5500X
CF: 1,000 Hz, 6,000 Hz, and 10,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: max., 120. Response: 25-20,000 Hz. 26 1/16H x 17 1/2W x 11 1/16D, 43 1/2 lbs. Price not available.

SP-7500X
CF: 1,000 Hz, 6,000 Hz, 10,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: max., 130. Response: 25-22,000 Hz. 26 1/16H x 17 1/2W x 11 1/16D, 47 4/5 lbs. Price not available.

SARAS

10
Acoustic suspension, 10" woofer, 1" hyperbolic tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 20. Response: 35-18,000 Hz ± 3 dB. 24H x 13 1/2W x 12D, 45 lbs. \$149.50.

20

Acoustic suspension. 12" woofer. 1" hyperbolic tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 20. Response: 30-20,000 Hz ± 3 dB. 25H x 15W x 12¼D. 50 lbs. \$199.50.

40

Acoustic suspension. 12" woofer. 5" midrange. 1" hyperbolic tweeter. CF: 550 and 5,000 Hz. Rated Z: 8. Power: min., 20. Response: 30-20,000 Hz ± 3 dB. 25H x 15½W x 12¼D. 58 lbs. \$279.50.

SCHOBER

LSS-10A

Phase inverter. 12" woofer. 8" tweeter. horn high frequency (optional at extra cost). CF: 250 Hz and 3,500 Hz. Controls: tweeter. Rated Z: 8. Power: min., 20; max., 70. Response: 32-18,000 Hz ± 5 dB. 34H x 24W x 16D. 60 lbs. kit, \$250.

LSS-100

Phase inverter. Two 12" woofers. 8" midrange. horn tweeter. horn high frequency. CF: 150 Hz, 1,000 Hz, and 3,500. Controls: tweeter. Rated Z: 8. Power: min., 20; max., 100. Response: 32-18,000 Hz ± 5 dB. 54H x 32W x 16D. 150 lbs. \$775.

H. H. SCOTT

S-11D

Acoustic suspension. 10" woofer. 4½" midrange. 1" dome tweeter. CF: 800 Hz and 3,500 Hz. Controls: 3-position tweeter/midrange switch. Rated Z: 6-8. Power: min., 10; max., 60. Response: 50-20,000 Hz ± 4 dB. ref. 76.7 dB/SPL at 1 meter. 24H x 14½W x 11¼D. 36 lbs. \$149.95.

S-15

Acoustic suspension. 10" woofer. 4½" midrange. 3" cone tweeter. CF: 800 Hz and 4,000 Hz. Controls: 3-position midrange/tweeter switch. Rated Z: 6-8. Power: min., 7; max., 50. Response: 55-18,000 Hz ± 4 dB. ref. 78.2 dB/SPL at 1 meter. 23½H x 11¼W x 9D. 24 lbs. \$134.95.

S-42

Acoustic suspension. 8" woofer. 1" dome tweeter. CF: 2,200 Hz. Controls: 3-position tweeter switch. Rated Z: 6-8. Power: min., 10; max., 35. Response: 55-20,000 Hz ± 4 dB. ref. 81.5 dB/SPL at 1 meter. 22H x 11¼W x 8½D. 22 lbs. \$79.95.

S-52

Acoustic suspension. 10" woofer. 1½" dome tweeter. CF: 1,000 Hz. Controls: 3-position tweeter level switch. Rated Z: 6-8. Power: min., 18; max., 60. Response: 45-17,000 Hz ± 4 dB. ref. 83 dB/SPL at 1 meter. 24H x 14½W x 10¼D. 40 lbs. \$114.95.

S-61

Acoustic suspension. 10" woofer. 4½" midrange. 1" dome tweeter. CF: 1,000 Hz and 5,000 Hz. Controls: 3-position midrange/tweeter level switch. Rated Z: 6-8. Power: min., 18; max., 25. Response: 45-20,000 Hz ± 4 dB. ref. 79.5 dB/SPL at 1 meter. 25H x 14½W x 11½D. 43 lbs. \$169.95.

S-71

Acoustic suspension. 12" woofer. 4½" mid-

range. two 1" dome tweeters. CF: 900 Hz and 4,500 Hz. Controls: 3-position midrange/tweeter level switch. Rated Z: 6-8. Power: min., 20; max., 100. Response: 42-20,000 Hz ± 4 dB. ref. 77 dB/SPL at 1 meter. 25H x 15¼W x 12¼D. 46 lbs. \$199.95.

SHERWOOD

Evolution Six

Acoustic suspension. 10" woofer. 3½" cone midrange. 1" dome tweeter. CF: 800 Hz and 4,000 Hz. Controls: 2-position tweeter switch. Rated Z: 8. Power: min., 17; max., 100. Response: 32-18,000 Hz ± 4 dB. ref. 90 dB/SPL at 1 meter. Sculptured removable grille. 25H x 14W x 10D. 44 lbs. \$149.95.

SONAB

OA12

Bass reflex. SC165 Carlsson woofer. two tweeters. CF: 1,800 Hz. Rated Z: 8. Power: min., 8; max., 70. Response: 37-18,000 Hz ± 3 dB. Uses patented Carlsson ortho-acoustic principle. Sold only in pairs. 18H x 8W x 14D. 16 lbs. \$199.

OA14

Bass reflex. SC165 Carlsson woofer. four tweeters. CF: 1,800 Hz. Rated Z: 8. Power: min., 8; max., 80. Response: 29-18,000 Hz ± 3 dB. Uses patented Carlsson ortho-acoustic principle. Sold only in pairs. 23H x 9W x 17D. 25 lbs. \$288.

OA116

Bass reflex. SC165 woofer, SC165 midrange. four tweeters. Rated Z: 8. 27H x 9W x 17D. 40 lbs. \$489.

OD-11

Bass reflex with tuned port. SC165 Carlsson woofer, tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 8; max., 60. Response: 45-18,000 Hz ± 3 dB. Uses Carlsson patented ortho-directional principle. Sold only in pairs. 10H x 10W x 10D. 13 lbs. \$149.

SONY

1000

Acoustic suspension. 8" cone woofer. 3" cone tweeter. CF: 1,500 Hz. Rated Z: 8. Power: min., 15; max., 50. Response: 50-18,000 Hz. 17 11/16H x 11 11/16W x 8¼D. 17 lbs. \$100 per pair.

1200

Acoustic suspension. 10" woofer. 3" cone tweeter. CF: 1,000 Hz. Controls: 2-position tweeter switch. Rated Z: 8. Power: min., 15; max., 50. Response: 45-18,000 Hz. 23½H x 13½W x 10D. 29 lbs. \$80.

A Note on Prices

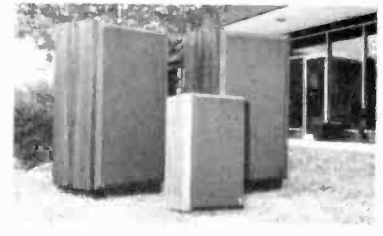
Prices shown in these pages are manufacturers' or importers' suggested retail prices, updated as is feasible by press time. They may be subject to variation in different locales and to discounts among different retailers. However, most established audio dealers advise that the less discount offered, the more the buyer can expect in the way of consultation, advice, and service.

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TDS

A musical instrument in itself. 4 staggered 12" woofers with a midrange and tweeter compliment also staggered. 1½" walls. Power amplifier range: 15-600 WRMS. 2 or 8 ohms impedance. TDS delivers thunderous sound with crisp, clear realism that must be heard to be accepted. **\$999.00**

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Speaker Systems
In elegant Cabinetry from
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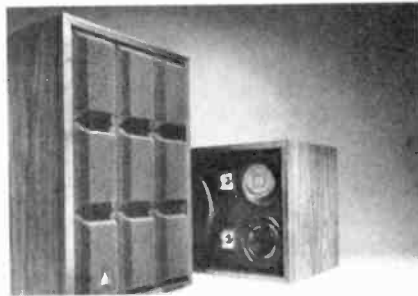
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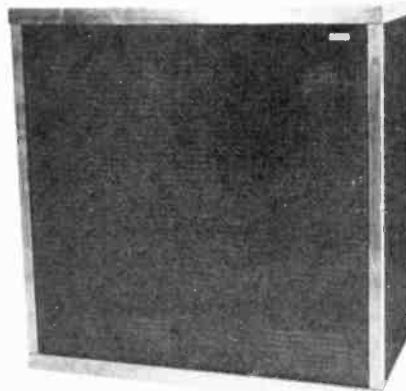
Sonab OD-11



Stark Designs SR-1



STR P12



STR Omega II



Superscope S-16A

1400

Acoustic suspension. 10" woofer. 1 1/2" soft dome midrange. 2" cone tweeter. CF: 800 Hz and 4,000 Hz. Controls: 3-position midrange and tweeter switches. Rated Z: 8. Power: min.. 20; max.. 80. Response: 40-20,000 Hz. 24H x 13 3/4W x 10 1/2D. 38 lbs.\$120.

1600

Acoustic suspension. 12" cone woofer. 2" soft dome midrange. 3/4" soft dome tweeter. CF: 800 Hz and 3,000 Hz. Controls: 3-position midrange and tweeter switches. Power: min.. 20; max.. 80. Response: 35-20,000 Hz. 26H x 14 1/4W x 12D. 50 lbs.\$150.

1800

Acoustic suspension. Two 10" cone woofers. 2" soft dome midrange. 3/4" soft dome tweeter. CF: 800 Hz and 3,000 Hz. Controls: 3-position midrange and tweeter switches. Rated Z: 8. Power: min.. 30; max.. 100. Response: 30-20,000 Hz. 27 1/2H x 14 1/4W x 12 1/2D. 60 lbs.\$200.

SOUNDCRAFTSMEN

SC-7

Acoustic suspension. 12" woofer. 5" midrange. 3" tweeter. CF: 500 Hz and 4,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min.. 10; max.. 60. Response: 20-20,000 Hz. Removable foam grille. 25 1/2H x 15W x 11 1/4D. 56 lbs.\$229.50.

SC-12ES

Acoustic suspension. 12" woofer. 5" midrange. two electrostatic elements. CF: 500 Hz and 1,000 Hz. Controls: ultrasonic limiter, electrostatic level, midrange, low frequency rolloff. Rated Z: 8. Power: min.. 20; max.. 150. Response 30-20,000 Hz ± 3 dB. 28H x 18W x 14D. 76 lbs.\$399.50.

SPEAKERLAB

1

Acoustic suspension. 8" woofer. 1/2" dome tweeter. CF: 2,500 Hz. Controls: tweeter. Rated Z: 4. Power: min.. 5; max.. 40. Response: 50-15,000 Hz ± 4 dB. Removable grille. 18 3/4H x 11 1/4W x 9 1/2D. 30 lbs.kit, \$59; assembled, \$89.

2

Acoustic suspension. 10" woofer. 1 1/2" mylar dome tweeter. CF: 1,250. Controls: tweeter. Rated Z: 4. Power: min.. 7; max.. 60. Response: 45-16,000 Hz ± 4 dB. Removable grille. 23 3/8H x 15 3/16W x 11 1/8D. 49 lbs.kit, \$89; assembled, \$139.

3

Acoustic suspension. 12" woofer. 6" cone midrange. 3/4" dome tweeter. CF: 700 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min.. 15; max.. 100. Response: 40-17,000 Hz ± 4 dB. Removable grille. 23 3/8H x 15 3/16W x 11 1/8D. 49 lbs.kit, \$142; assembled, \$199.

4

Acoustic suspension. 12" woofer. 6" cone midrange. horn tweeter. CF: 700 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min.. 15; max.. 100. Response:

40-17,000 Hz \pm 4 dB. Removable grille. 23 $\frac{3}{4}$ "H x 15 $\frac{3}{16}$ "W x 11 $\frac{1}{4}$ "D. 49 lbs.kit, \$173; assembled, \$229.

7

Acoustic suspension. 12" and 10" woofers, horn midrange, horn tweeter. CF: 700 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 4. Power: min., 15; max., 150. Response: 35-17,000 Hz \pm 3 dB. 25H x 18W x 15 $\frac{1}{2}$ "D. 85 lbs.kit, \$272; assembled, \$389.

K

"Folded corner horn." 15" woofer, horn midrange, horn tweeter. CF: 400 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 4. Power: min., 10; max., 200. Response: 30-17,000 Hz \pm 4 dB. Removable grille. 50 $\frac{3}{4}$ "H x 32 $\frac{1}{4}$ "W x 28" front to corner. 170 lbs. kit (preassembled particle board bass unit, \$399; kit (walnut), \$595; kit (complete disassembled in walnut), \$389.

STARK DESIGNS

SR-1

Acoustic suspension. 10" cone woofer, 5" cone midrange, 1" dome tweeter. CF: 450 Hz and 4,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 10; max., 40. Tweeter dispersion can be directed, sculptured removable grille available in 5 colors, optional walnut floor basses at \$30 per pair (FB-1, FB-2, FB-3). 24H x 15W x 10 $\frac{1}{2}$ "D. 42 lbs.\$165.

SR-2

Acoustic suspension. 12" cone woofer, 5" cone midrange, 1" dome tweeter. CF: 450 Hz and 4,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 12; max., 50. Same features as model SR-1. 24H x 15W x 13D. 48 lbs.\$195.

SR-3

Acoustic suspension. 12" woofer, two 5" midranges, two 1" dome tweeters. CF: 450 Hz and 4,500 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 15; max., 60. Same features as model SR-1, one midrange and tweeter rear mounted (both tweeters can be directed). 24H x 16 $\frac{1}{2}$ "W x 13D. 57 lbs.\$240.

STR

P10

Tube-vented reflex. 10" woofer, 12 cm midrange, 1 piezoelectric tweeter. CF: 1,500 Hz and 5,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 5; max., 75. Response: 50-20,000 Hz \pm 5 dB, ref. 94 dB. Fuse protection, 5-yr. warranty. 25 $\frac{1}{2}$ "H x 15 $\frac{1}{2}$ "W x 13 $\frac{3}{4}$ "D. 65 lbs.\$199.

P12

Slot radiator. 12" woofer, 12 cm midrange, two piezoelectric tweeters. CF: 220 Hz and

6,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 20; max., 150. Response: 30-20,000 Hz \pm 5 dB, ref. 94 dB. Fuse protection, 5-yr. warranty. 31 $\frac{1}{4}$ " x 15 $\frac{1}{2}$ "W x 15 $\frac{1}{2}$ "D. 80 lbs.\$289.

Beta

Tube-vented bass reflex, 8" woofer, piezoelectric tweeter. CF: 5,000 Hz. Rated Z: 8. Power: min., 3; max., 65. Response: 55-20,000 Hz \pm 5 dB, ref. 94 dB. Fuse protection, 5-yr. warranty. 16H x 10W x 9 $\frac{1}{4}$ "D. 18 lbs.\$64.50.

Gamma

Acoustic suspension. 10" woofer, phenolic midrange, piezoelectric tweeter. CF: 1,500 Hz and 10,000 Hz. Controls: tweeter (vinyl version has no controls). Rated Z: 8. Power: min., 5; max., 75. Response: 37-21,000 Hz \pm 3 dB, ref. 94 dB. Fuse protection, 5-yr. warranty. 23 $\frac{3}{4}$ "H x 12 $\frac{1}{2}$ "W x 15D. 43 lbs.\$108; vinyl: \$149; walnut,

Omega II

Dual slot radiator. Two 12" woofers, 8" midrange, dome tweeter, piezoelectric tweeter. CF: 150 Hz, 3,000 Hz, and 5,000 Hz. Controls: woofer, midrange, and tweeter. Rated Z: 8. Power: min., 20; max., 250. Response: 23-20,000 Hz \pm 3 dB, ref. 94 dB. Fuse protection, lifetime warranty, can be bi- or tri-amplified. 31 $\frac{1}{4}$ " x 31 $\frac{1}{4}$ "W x 15 $\frac{1}{4}$ "D. 150 lbs.\$499.

Sigma II

Acoustic suspension. 12" woofer, 4.7" midrange, 1 dome tweeter, 1 piezoelectric tweeter. CF: 800 Hz, 3,000 Hz, and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 15; max., 200. Response: 28-20,000 Hz \pm 4 dB, ref. 94 dB. Fuse protection, lifetime warranty. 31 $\frac{1}{4}$ "H x 15 $\frac{1}{2}$ "W x 15 $\frac{1}{4}$ "D. 85 lbs.\$329.

SUPERSCOPE

S-16A

Bass reflex. 6 $\frac{1}{2}$ " full range with wizzer cone. Rated Z: 8. Power: min., 5; max., 15. Response: 80-17,000 Hz. 17H x 10 $\frac{1}{2}$ "W x 7D. 7 lbs.\$69.95 per pair.

S-26A

Bass reflex. 6 $\frac{1}{2}$ " woofer, 3" tweeter. CF: 5,000 Hz. Rated Z: 8. Power: min., 5; max., 20. Response 60-18,000 Hz. 19 $\frac{1}{2}$ "H x 11 $\frac{1}{4}$ "W x 7D. 9 $\frac{1}{2}$ lbs.\$79.95 per pair.

S-208

Air suspension. 8" woofer, 3" tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 5; max., 50. Response: 50-20,000 Hz. 96 dB at 0.5 meter. 19 $\frac{1}{2}$ "H x 11 $\frac{1}{4}$ "W x 8 $\frac{1}{2}$ "D. 19 lbs.\$199.90 per pair.

S-210

Air suspension. 10" woofer, 3" tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 5; max., 50. Response: 40-20,000 Hz. 32 $\frac{1}{2}$ "H x 12 $\frac{1}{2}$ "W x 9 $\frac{1}{2}$ "D. ref. 96 dB/SPL at 0.5 meter. 22 $\frac{3}{4}$ lbs.\$139.95.

S-212A

Air suspension. 12" woofer, 3" tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 5; max., 50. Response: 30-20,000 Hz, ref. 96 dB/SPL at 0.5 meter. 23 $\frac{1}{2}$ "H x 14 $\frac{1}{2}$ "W x 11D. 27 lbs.\$169.95.

S-312

Similar to model S-212A.\$199.95.

the great Escape



Cue up your favorite record, sit back, relax... suddenly you're surrounded by total sound. A spectacular and utterly different musical experience — **The Lee Music Chair.**

The Lee Music Chair is a new version of the famous Lee Sound Chambers. Designed on the principle of the sound engineer's anechoic (echoless) chamber, it's the ideal relationship between listener and sound source.

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Understanding the Numbers

For detailed explanations of the technical "shorthand" used in the equipment directory, the reader is invited to study the articles in this volume, especially those dealing with how speakers work, and how they are evaluated.



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Pomona, California 91767
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SYLVANIA

GTE 210

Air suspension, 10" woofer, 1½" dome midrange/tweeter. CF: 1,500 Hz. Controls: two upper midrange level switches. Rated Z: 8. Power: min., 10; max., 100. Response: 33-15,000 Hz ± 3 dB. 24H x 15¾W x 11¾D. 51 lbs.\$119.95.

AS 210A

Similar to model GTE 210.

AS5706

Air suspension, 6" woofer, 3" tweeter. CF: 5,000 Hz. Rated Z: 8. Power: min., 5; max., 25. Response: 53-12,000 Hz ± 6 dB. 14¾H x 9¾W x 6¾D. 16½ lbs.\$69.90 per pair.

AS5708

Air suspension, 8" woofer, 3" tweeter. CF: 5,000. Rated Z: 8. Power: min., 5; max., 35. Response: 60-12,000 Hz ± 5 dB. 18¾H x 12W x 9D. 21½ lbs.\$99 per pair.

AS5710

Air suspension, 10" woofer, 3" midrange, 2½" tweeter. CF: 2,000 Hz and 7,000 Hz. Rated Z: 8. Power: min., 5; max., 50. Response: 45-13,000 Hz ± 5 dB. 22¾H x 14¾W x 11¾D. 35 lbs.\$159.90 per pair.

AS5712

Air suspension, 12" woofer, 4" midrange, 1" dome tweeter. CF: 1,500 Hz and 6,000 Hz. Controls: midrange/tweeter level switch. Rated Z: 8. Power: min., 5; max., 50. Response: 40-14,000 Hz ± 5 dB. 25¾H x 16¾W x 11¾D. 46½ lbs.\$229.90 per pair.

TANNOY

ERA 55

Infinite baffle. "12/60 12" integrated (woofer and tweeter) system." CF: 1,000 Hz. Controls: treble. Rated Z: 8. Power: min., 15; max., 55. Response: 32-20,000 Hz ± 5 dB, ref. 90 dB/SPL at 1 meter. 31½H x 23W x 17D. 65 lbs.\$420.

Integra 40

Bass reflex. "12/60 12" integrated (woofer & tweeter) system." CF: 1,000 Hz. Controls: treble. Rated Z: 8. Power: min., 15; max., 40. Response: 35-20,000 Hz ± 5 dB, ref. 90.5 dB/SPL at 1 meter. 23½H x 15¾W x 11¾D. 40 lbs.\$330.

Regent 75

Infinite baffle. "15/85 integrated (woofer and tweeter) system." CF: 1,000 Hz. Controls: treble. Rated Z: 8. Power: min., 15; max., 75. Response: 35-20,000 Hz ± 5 dB, ref. 92 dB/SPL at 1 meter. 27¾H x 23½W x 19¾D. 85 lbs.\$507.

How Should A Speaker Sound?

The extent to which a speaker produces no sound other than that which it is "ordered" to produce by the amplifier signal is a practical measure of its fidelity or accuracy. This quality is, to some extent, indicated by technical data but the ultimately true test is to listen to the speaker used in a sound playback system.



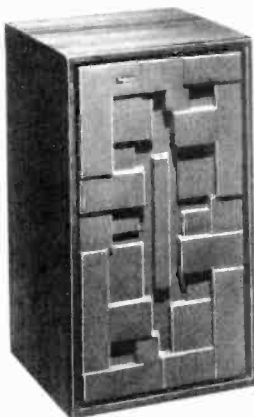
Superscope S-212A



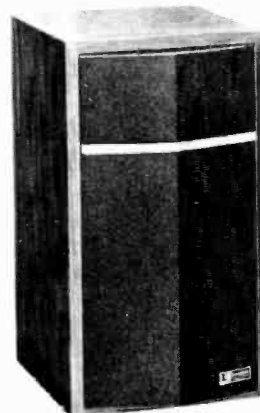
Tannoy ERA 55



Tannoy Royale 85



Technics T-300



Tempest Lab Series 2

Royale 85

Infinite baffle. "15/85 integrated (woofer and tweeter) system." CF: 1,000 Hz. Controls: treble. Rated Z: 8. Power: min., 15; max., 85. Response: 30-20,000 Hz \pm 5 dB, ref. 92 dB/SPL at 1 meter. 42H x 23½W x 17¼D.....\$597.

TECHNICS (by PANASONIC)

T-200

Acoustic suspension. 10" cone woofer. 1¼" ring tweeter. CF: 1,800 Hz. Controls: tweeter level switch. Rated Z: 8. Power: min., 10; max., 40. Response: 44-18,000 Hz \pm 3 dB, ref. 90 dB/SPL at 1 meter. 21¼H x 12W x 10½D. 26 lbs.\$99.95.

T-300

Acoustic suspension. 10" cone woofer. 3" midrange. 2" dome super-tweeter. CF: 1,500 Hz and 7,500 Hz. Controls: midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 50. Response: 40-20,000 Hz \pm 3 dB, ref. 90 dB/SPL at 1 meter. 24¾H x 13¾W x 12½D. 32 lbs.\$179.95.

T-400

Acoustic suspension. 12" cone woofer. 5" cone midrange. 3½" cone tweeter. two 2" dome/cone super-tweeters. CF: 700 Hz, 3,000 Hz, and 7,500 Hz. Controls: midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 90. Response: 38-20,000 Hz \pm 3 dB, ref. 92 dB/SPL at 1 meter. Removable base. 27H x 15W x 13¼D. 50 lbs.\$279.95.

T-500

Acoustic suspension. Two 10" cone woofers. 5" midrange. two 1¼" ring tweeters. two 2" dome/cone super-tweeters. CF: 600 Hz, 2,000 Hz, and 8,000 Hz. Controls: midrange and tweeter level switches. Rated Z: 8. Power: min., 10; max., 100. Response: 35-20,000 Hz \pm 3 dB, ref. 92 dB/SPL at 1 meter. Removable base. 29H x 18¾W x 14½D. 44 lbs.\$429.95.

TEMPEST

Lab Series 1

Ducted slot. 12" woofer. Heil air-motion transformer tweeter. CF: 1,500 Hz. Controls: high-frequency attenuator, environmental equalizer. Rated Z: 6. Power: min., 10; max., 60. Response: 30-25,000 Hz. Choice of grille colors. 27H x 15W x 13¼D. 52 lbs.\$199.

Lab Series 2

Ducted slot. 10" woofer. Heil air-motion transformer tweeter. CF: 1,500 Hz. Controls: high-frequency attenuator, environmental equalizer. Rated Z: 6. Power: min., 10; max., 50. Response: 30-25,000 Hz. Choice of grille colors. 24½H x 13¾W x 13½D. 42 lbs.\$169.

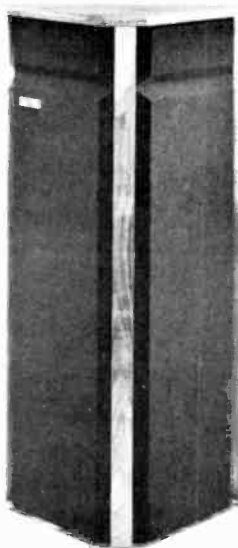
Lab Series 3

Ducted slot. 8" woofer. Heil air-motion transformer tweeter. CF: 1,500 Hz. Controls: environmental equalizer. Rated Z: 6. Power: min., 10; max., 40. Response: 40-25,000 Hz. Choice or grille color. 22H x 12¾W x 10¾D. 33 lbs.\$129.

Lab Series 3e

Same as Lab Series 3 except without controls.\$99.

The next logical step



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Twenty years ago Edgar Villchur, with his revolutionary acoustic suspension design, demonstrated the advantages of treating the woofer and its enclosure as a system rather than separate components. Today, nearly all loudspeakers embody this concept. Roy Allison (a professional associate of Mr. Villchur for many years) has now extended the "system" one logical step further, to include the listening room itself. The result is an improvement by one order of magnitude in the accuracy of the reproduced sound field.

Descriptive literature on ALLISON loudspeaker systems which includes technical specifications is available on request.

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DJ54H

TOSHIBA

SS 510

"Pressure balance." 10" woofer, 4 1/4" midrange, 1 1/2" dome tweeter. CF: 800 Hz and 5,000 Hz. Controls: midrange and tweeter. Rated Z: 8. Power: min., 8; max., 50. Response: 20-20,000 Hz. ref. 90 dB/SPL at 1 meter. 23 1/4"H x 13 1/2"W x 12 3/4"D. 34 1/2 lbs.\$229.95.

ULTRALINEAR

Model 50

Bass reflex. 10" woofer. 3" tweeter. CF: 2,500 Hz. Rated Z: 8. Power: min., 3; max., 30. Response 40-1,700 Hz. Circuit breaker. "reverse-a-foam" grille. 23 1/8"H x 11 1/4"W x 9 1/4"D. 17 lbs.\$79.95.

Model 75

Bass reflex. 12" woofer. 3" tweeter. Rated Z: 8. Power: min., 5; max., 35. Response: 35-17,000 Hz. Circuit breaker, choice of grille colors. 24 3/8"H x 14 1/2"W x 9 1/4"D. 27 lbs.\$99.95.

Model 100A

Bass reflex. 12" woofer, 4 1/2" midrange, 3" tweeter, CF: 1,500 Hz. and 4,000 Hz. Rated Z: 8. Power: min., 5; max., 40. Response: 32-17,500 Hz. Circuit breaker, choice of grille colors. 24 3/8"H x 14 1/2"W x 12"D. 32 lbs.\$119.95.

Model 200

Air suspension. 12" woofer. 5" midrange. 2" super-tweeter. CF: 1,500 Hz and 4,000 Hz. Controls: midrange. Rated Z: 8. Power: min., 10; max., 50. Response: 28-20,000 Hz. Circuit breaker, choice of grille colors. 24 3/8"H x 14 1/2"W x 12"D. 45 lbs.\$159.95.

Model 250

Air suspension. 15" woofer, 6" midrange, 3" tweeter, 2" super-tweeter. CF: 800 Hz, 2,600 Hz. and 6,000 Hz. Controls: midrange. Power: min., 15; max., 70. Response: 25-20,000 Hz. Circuit breaker. 25"H x 23 1/2"W x 12"D. 60 lbs.\$209.95.

Model 1000

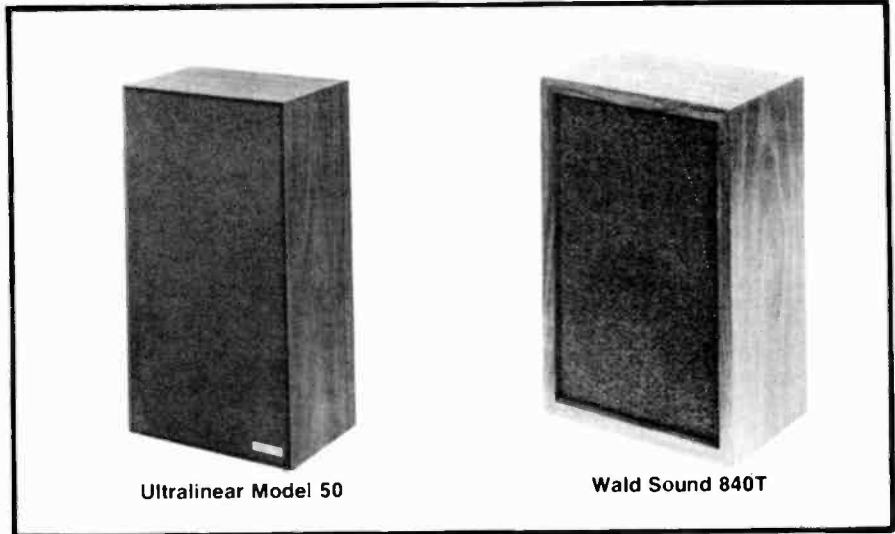
Air suspension. 10" woofer, 3 1/2" tweeter. CF: 2,600 Hz. Controls tweeter. Rated Z: 8. Power: min., 25; max., 60. Response: 35-22,000 Hz. Circuit breaker, patented inertial equalizer disc and dual mode array tweeters. 27"H x 14 1/2"W x 12"D. 42 lbs.\$199.95.

1060WT

Slot loaded reflex. 10" woofer, two 5" midranges, three phenolic ring tweeters. CF: 700 Hz, 1,000 Hz, 3,000 Hz. and 6,000 Hz. Controls: potentiometer for mid and high frequency. Rated Z: 8. Power: min., 20; max., 75. Response: 30-18,000 Hz \pm 4 dB. 40"H x 14"W x 12"D. 55 lbs.\$259.95.

Monthly Reports on Speakers

For detailed laboratory reports on all types of new equipment, including speaker systems, read the monthly issues of HIGH FIDELITY magazine. In addition, test reports are updated and collected yearly in the special publication "HIGH FIDELITY'S TEST REPORTS." Reports are based on lab measurements and controlled listening tests. Manufacturers are not permitted to read reports in advance of publication.



Ultralinear Model 50

Wald Sound 840T

1220

"Sealed enclosure." 12" woofer, 3" midrange. CF: 1,500 Hz. Rated Z: 8. Power: min., 4; max., 30. Response: 65-14,000 Hz. 24 13/16"H x 15 3/16"W x 10 1/4"D. 21 lbs.\$64.95.

1230

"Sealed enclosure." 12" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 3,500 Hz. Rated Z: 8. Power: min., 4; max., 35. Response: 65-14,000 Hz. 24 13/16"H x 15 3/16"W x 10 1/4"D. 22 lbs.\$69.95.

1230W

Air suspension. 12" "rolled-edge" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 3,500 Hz. Controls: Potentiometer for mid and high frequency. Rated Z: 8. Power: min., 8; max., 40. Response: 45-15,000 Hz \pm 6 dB. 24 3/8"H x 15"W x 10 1/2"D. 32 lbs.\$110.95.

1230WD

Air suspension. 12" woofer, 5" midrange, phenolic ring tweeter. CF: 900 Hz and 3,500 Hz. Controls: potentiometer for mid and high frequency. Rated Z: 8. Power: min., 10; max., 45. Response: 35-18,000 Hz \pm 5 dB. 24 3/8"H x 15"W x 10 1/2"D. 35 lbs.\$139.95.

1530

"Sealed enclosure." 15" woofer, 5" midrange, 3" tweeter. CF: 900 Hz and 3,500 Hz. Rated Z: 8. Power: min., 8; max., 45. Response: 45-14,000 Hz. 25 11/16"H x 17 13/16"W x 13 1/2"D. 26 lbs.\$99.95.

1530W

Air suspension. 15" "free-edge" woofer, 5" tweeter, 3" phenolic ring tweeter. CF: 900 Hz and 3,500 Hz. Controls: potentiometer for mid and high frequency. Rated Z: 8. Power: min., 15; max., 50. Response: 35-18,000 Hz \pm 6 dB. 25 3/8"H x 17 3/8"W x 13 1/2"D. 40 lbs.\$149.95.

1540W

Air suspension. 15" "free-edge" woofer, 5" midrange, 3" tweeter, phenolic ring tweeter. CF: 900 Hz, 3,500 Hz, and 6,000 Hz. Controls: potentiometer for mid and high frequency. Rated Z: 8. Power: min., 20; max., 60. Response: 30-18,000 Hz \pm 6 dB. 26 1/2"H x 21 1/8"W x 15"D. 52 lbs.\$194.50.

Trend 1

Air suspension. 8" "rolled-edge" woofer,

phenolic ring tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 8; max., 20. Response: 60-18,000 Hz \pm 6 dB. 17 1/4"H x 11 1/4"W x 8 3/4"D. 16 lbs.\$49.95.

Trend 2

Air suspension. 10" "rolled-edge" woofer, phenolic ring tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 10; max., 30. Response: 40-18,000 Hz \pm 6 dB. 23"H x 13 3/8"W x 11 1/4"D. 28 lbs.\$74.95.

Trend 4

Bass reflex. 12" "rolled-edge" woofer, 4 1/2" cone midrange, phenolic ring tweeter. CF: 900 Hz and 3,500 Hz. Controls: mid and high frequency. Rated Z: 8. Power: min., 12; max., 45. Response: 40-18,000 Hz \pm 6 dB. 23 3/8"H x 14 1/2"W x 12 1/4"D. 32 lbs.\$109.95.

WALD SOUND

620

"Sealed Enclosure." 6" woofer, 2 1/2" tweeter. CF: 3,500 Hz. Rated Z: 8. Power: min., 2; max., 12. Response: 100-12,000 Hz. 14"H x 10"W x 5"D. 6 lbs.\$22.95.

820

"Sealed Enclosure." 8" woofer, 3 1/2" tweeter. CF: 3,000 Hz. Rated Z: 8. Power: min., 2; max., 15. Response: 80-12,000 Hz. 17 1/4"H x 11 1/4"W x 8"D. 10 lbs.\$34.95.

820W

Air suspension. 8" "free-edge" woofer, 3" tweeter. CF: 1,800 Hz. Rated Z: 8. Power: min., 8; max., 20. Response: 50-15,000 Hz \pm 6 dB. 18 3/8"H x 13"W x 10 1/2"D. 21 lbs.\$59.95.

830

"Sealed enclosure." 8" "rolled edge" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 3,500 Hz. Rated Z: 8. Power: min., 4; max., 18. Response: 80-13,000 Hz. 22 13/16"H x 13 3/16"W x 10 1/4"D. 18 lbs.\$49.95.

830W

Air suspension. 8" "free-edge" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 3,500 Hz. Rated Z: 8. Power: min., 8; max., 22. Response: 50-15,000 Hz \pm 6 dB. 18 3/8"H x 13"W x 10 1/2"D. 22 lbs.\$69.95.

840T

"Duel reflex," tuned port. 8" woofer, 3" tweeter. CF: 1,500 Hz. Rated Z: 6-8. Power: min., 5; max., 25. Response: 60-14,000 Hz. 34H x 11W x 9¼D. 22 lbs.\$69.95.

1020

"Sealed enclosure." 10" woofer, 3" tweeter. CF: 2,000 Hz. Rated Z: 8. Power: min., 3; max., 20. Response: 80-14,000 Hz. 22 13/16H x 13 3/16W x 10¼D. 18 lbs.\$54.95.

1020W

Air suspension. 10" woofer, 3" tweeter. CF: 1,500 Hz. Controls: high-frequency potentiometer. Rated Z: 8. Power: min., 8; max., 30. Response: 40-15,000 Hz ± 6 dB. 22½H x 13W x 10½D. 26 lbs.\$79.95.

1030

"Sealed enclosure." 10" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 3,500 Hz. Rated Z: 8. Power: min., 3; max., 20. Response: 80-14,000 Hz. 22 13/16H x 13 3/16W x 10¼D. 19 lbs.\$59.95.

1030W

Air suspension. 10" woofer, 5" midrange, 3" tweeter. CF: 1,000 Hz and 3,500 Hz. Controls: potentiometer for mid and high frequency. Rated Z: 8. Power: min., 8; max., 32. Response: 40-15,000 Hz ± 6 dB. 22½H x 13W x 10½D. 26 lbs.\$99.95.

1040WDR

Passive radiator. 10" woofer, 10" low-frequency reinforcement radiator. 4½" midrange, phenolic ring tweeter. CF: 1,700 Hz and 4,700 Hz. Controls: potentiometer for mid and high frequency. Rated Z: 8. Power: min., 20; max., 45. Response: 35-18,000 Hz ± 5 dB. 25½H x 15W x 13½D. 40 lbs.\$169.95.

WHITE ELECTRONICS

Shotglass III

Organ pipe bass. Four 5" patented glass-cone woofers with parabolic surround. 3½" tweeter. CF: 1,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 25; max., 70. Response: 30-20,000 Hz. 5-yr. warranty. 28H x 8W x 8D. 24 lbs.\$159.50.

Shotglass IIIa

Organ pipe bass. Four 5" patented glass-cone woofers with parabolic surround. two 3½" tweeters. CF: 1,000 Hz. Controls: tweeter. Rated Z: 8. Power: min., 25; max., 100. Response: 25-20,000 Hz. 5-yr. warranty. 36H x 8W x 8½H. 28 lbs.\$199.

YAMAHA

670

Acoustic suspension. 10" woofer. 2½" soft dome midrange. ¼" soft dome tweeter. CF: 800 Hz and 6,000 Hz. Controls: separate midrange and tweeter levels. Rated Z: 8. Power: min., 6.3; max., 50. 22¼H x 12¾W x 10¼D. 42 lbs.\$560 per pair.

690

Acoustic suspension. 12" woofer, 3" soft dome midrange. 1¼" soft dome tweeter. CF: 800 Hz and 6,000 Hz. Controls: separate midrange and tweeter levels. Rated Z: 8. Power: min., 4; max., 60. 24¼H x 13¾W x 11½D. 48 lbs.\$460 per pair.

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DJ57

Buying Guide to Speaker Systems Shopping List

As you read through the directory, why not use the space below to jot down the speaker systems you're interested in. Then take along your copy of the 1976 Buying Guide to Speaker Systems when you visit your local high fidelity equipment store. Remember, prices may vary from region to region due to Fair Trade or discounting practices.

Speaker Systems Glossary

A/B test A listening test in which two similar audio devices (or program sources) are compared by rapidly switching between them while the rest of the system is unchanged, except for relative volume adjustment if needed.

acoustic or air suspension See "speaker enclosure."

baffle Panel on which a loudspeaker is mounted; sometimes used colloquially to refer to the complete enclosure, especially when it is a fully sealed box.

balance As used in speaker parlance, the term "balance" refers to suitable proportions of low, middle, and high frequencies that are reproduced by the speaker system amply but not in such a way that one portion of the total musical spectrum dominates or is slighted.

bass reflex See "speaker enclosure."

biamplication Use of separate amplifiers to handle highs and lows that are first divided by an electronic crossover circuit. The "bass amplifier" drives the woofer, while the "treble amplifier" drives the tweeter, in a two-way speaker system. A further refinement of this idea is "triamplification" in which the total audio spectrum is divided three ways and fed to three amplifiers, each of which energizes its own driver in a three-way speaker system. The electronic crossover is inserted after the normal preamplifier stages and it in turn feeds the individual basic or power amplifiers. Performance claims made for this type of hookup include improved damping, more effective coupling of amplifier power to speakers, and reduce IM distortion.

channel A single, complete through-

path, as from microphone to loudspeaker.

channel balance See "balance."

channel separation The degree to which stereo channels are kept apart from each other. Expressed in decibels: the greater the number, the more the separation.

compliance In speaker parlance, the ability of the speaker to vibrate in accordance with the signals from an amplifier. "High compliance" speakers, also known as "long-throw" speakers, are typically used in air-suspension systems.

cps Abbreviation for cycles-per-second (of frequency), an obsolete term. Now called hertz, abbreviated Hz.

crossover A frequency at which other frequencies below and above it are separated. A crossover or dividing network, for instance, separates the highs and lows in a woofer/tweeter speaker system.

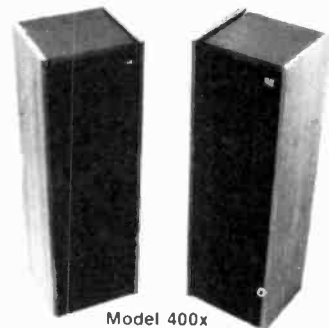
damping A speaker's ability to control "ringing." Ringing is an undesirable tendency of the speaker to continue to respond after the driving signal has been removed. Excessive ringing causes distortion and a blurring of transient quality. A well-damped speaker overcomes this tendency. Speaker systems that load to a room via port or horn openings are inherently better damped than sealed-box systems. The latter depend on special construction of the voice-coil for their damping, and in addition seem to benefit from high damping factors in the driving amplifier.

damping factor The ratio of load impedance (the speaker load) to an amplifier's internal impedance. A ratio of 10 is

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Speaker Systems Glossary

generally considered normal for high fidelity use; most of today's amplifiers—because of their internal solid-state circuitry—typically have damping factors well over 10.

decibel Abbreviated dB, this is a unit of change in the intensity of a signal. An increase is expressed as a + number of dB; a decrease, as a - number. No change is stated as 0 dB. Zero dB also is the starting level or reference level from which changes are measured. The smallest change the ear can detect is said to be 1 dB. A two-to-one change in loudness, as heard by the ear, is given as 10 dB. A two-to-one change in electrical power is 3 dB; a two-to-one change in voltage is 6 dB.

difference The signal energy representing the differences in information between the signals in two or more stereo channels. A difference signal is produced when stereo signals differing in electrical polarity or in intensity are mixed together in opposing polarity ("A"—"B").

DIN Letters stand for Deutsche Industrie Norm and designate performance standards followed in Europe as well as the type of unitized connecting plug and its mating socket in which a number of pins and holes enable more than one function or more than one channel to be handled by a single connector.

dipole Also known as doublet, this term describes a loudspeaker that radiates equally from both sides of its sound-producing element; such a speaker has no nominal front or back.

directivity A tendency of a loudspeaker to concentrate its sonic output in a beam, thus sounding stronger on axis, and progressively weaker off axis. This tendency, when pronounced, can lend the sound a harsh sheen and actually is classified as a form of distortion. Since directivity tends to increase as frequency rises, it becomes a problem in the upper midrange and highs. "Omnidirectional" (or more correctly multidirectional) speakers use some kind of technique to avoid beaming and to radiate the mids and highs in a more uniform dispersion pattern.

distortion Any measurable or audible difference between the audio signal fed into an audio device or system and the signal coming out of it. Distortions of various kinds are always present to some degree in every audio component, but careful design can keep them sufficiently low as to be inaudible or barely so. See also "doubling," "harmonic distortion," "IM distortion," "phase."

doubling A speaker's tendency to distort in the bass region by producing harmonics of bass tones rather than the pure tones. Doubling typically increases as frequency is lowered and/or as the speaker is driven harder. Freedom from doubling is one of the hallmarks of good low-frequency response.

driver A single loudspeaker or "speaker element" without its enclosure or baffle; any of the individual speakers used in a speaker system.

dropout In speaker parlance, this term refers to relative losses of certain tones when the output of a speaker system is lowered in volume.

dynamic range The span of volume between loud and soft signals, expressed in dB. A speaker's ability to cover the normal dynamic range of program material is one of the hallmarks of its accuracy as a sound reproducer.

efficiency A ratio, often expressed as a percentage, of signal output to input; often used to estimate the power needed to drive a loudspeaker, and in effect the same as the "sensitivity" of a loudspeaker.

equalization Altering the frequency response deliberately for a desired effect. There are special auxiliary networks or devices which, inserted into a playback system before the loudspeaker and/or power amplifier, may be used to modify the system's sound to compensate for variations in program material, room acoustics, and the response of individual components in the system. These devices can do so more precisely and more effectively than conventional tone controls.

feedback Return of part of an output signal to an earlier stage. Controlled electrical feedback, of specific types and amounts, is used in amplifier circuit design and in special speaker/amplifier systems. "Acoustic feedback" describes the spurious return of part of a speaker's output to the system input to cause noise

and distortion. A typical form is a live microphone picking up sound from speakers being used for sound-reinforcement or public-address work, or as monitors in recording. In a home music system, a similar type of acoustical feedback occurs when the phono pickup senses some of the output from the speaker. This signal then is amplified along with the desired signal to cause harsh noises. Acoustical feedback of this type usually is cured by increasing the distance between speaker and turntable.

folded horn See "speaker enclosure."

frequency response A speaker's ability to reproduce a range of tones accurately. To be meaningful, a statement of frequency response should include specific dB variations from flat response (i.e., \pm a number of dB), and also should state the sound-pressure-level (in dB/SPL) at which the measurement was made (e.g., 90 dB/SPL).

ground A point of zero voltage, also known as "earth" in Britain; the "common" or "negative" terminal in speaker hookups.

harmonic A tone whose frequency is a multiple of another, lower-frequency tone (fundamental). Musical sounds are comprised of a fundamental and a number of harmonics.

harmonic distortion The addition of spurious harmonics to the signal. Expressed as a percentage; the lower the number, the better—although audio experts disagree as to the importance of harmonic distortion in loudspeaker output.

hertz Abbreviated Hz, this term has replaced "cycles-per-second."

Hz Abbreviation for hertz, meaning cycles-per-second of any periodic phenomenon such as audio or radio frequencies.

IM abbreviation for "intermodulation" and most commonly used to denote "intermodulation distortion," q.v.

impedance Total load presented to a circuit or signal-handling device. Electrical impedance in ohms is opposition to alternating current; it is the load on a source of alternating voltage, and consists of "pure resistance" combined with inductive and/or capacitive reactances. The electrical impedance value of most speaker systems used in high fidelity is 8

ohms; a few are of 4 ohms, and some are of 16 ohms. The lower the impedance (the less ohms) of a speaker, the more power it draws from an amplifier.

Impedances, or loads, connected in series are additive (e.g., two 8-ohm speakers in series become a 16-ohm load). Impedances in parallel are subtractive (the same two 8-ohm speakers in parallel become a 4-ohm load). To determine the net impedance of dissimilar loads in parallel, use the formula:

$$Z_1 = \frac{1}{Z_1 + Z_2}, \text{ etc.}$$

Thus, for example, a 16-ohm and an 8-ohm speaker in parallel present a total impedance of $5\frac{1}{3}$ ohms. "Acoustic impedance" refers to the load of air "seen" by a speaker as it vibrates to produce sound in a given environment. Because of the interaction of acoustical load and speaker, changes in the former can make the same speaker sound different.

input In speaker parlance, the signal from an amplifier that is applied to the speaker to be converted to sound.

infinite baffle See "speaker enclosure."

intermodulation (IM) distortion The introduction of spurious signals as the result of interaction between two or more simultaneously reproduced tones, causing a smearing or veiling of the sound. Expressed as a percentage; the lower the number, the better. IM in speakers has been postulated as a serious cause of a form of distortion, although there is as yet no widespread agreement on how it should be measured. On the other hand, there is wide agreement that the use of more than one driver (e.g., woofer and tweeter) to reproduce the full audible spectrum is a way of reducing IM.

k Abbreviation for kilo.

kHz Abbreviation for kilohertz, which is one thousand hertz. Thus, 3 kHz means 3,000 Hz.

kilo One thousand (1,000).

labyrinth See "speaker enclosure."

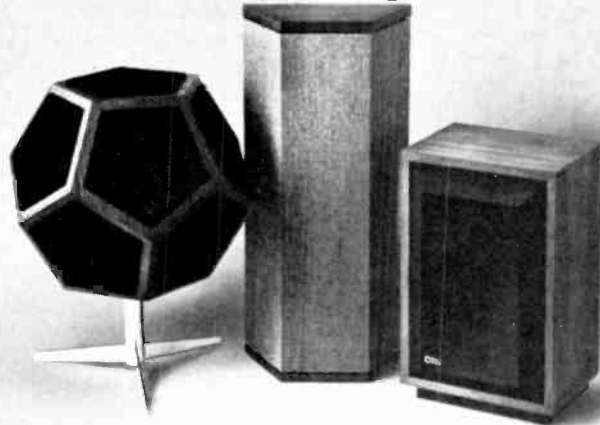
level The intensity or amplitude of a signal.

load See "impedance."

long-throw speaker See "compliance."

m Abbreviation for milli.

Some people make 2-faced speakers



We make 4-faced, 6-faced, and 12-faced speakers

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Speaker Systems Glossary

M Abbreviation for mega.

matching In speaker parlance, the term refers to correctly mating a speaker system to an amplifier in terms of power requirements and capability, and at the recommended impedance.

mega One million (1,000,000).

micro One-millionth (1/1,000,000).

mil One one-thousandth (1/1,000) of an inch. Tape thickness, stylus size, and wire diameter are usually stated in mils.

milli One-thousandth (1/1,000).

monitor A "monitor" speaker is any speaker used for listening critically to a signal that is being primarily directed to some other purpose, such as recording or broadcasting. What constitutes a "monitor" speaker is largely a matter of personal choice on the part of a recording or broadcast technician; in general, the term has come to mean an accurate speaker with high power capabilities.

μ (mu) Abbreviation for micro.

octave The musical interval between two pitches whose fundamental frequencies differ by a ratio of 2 to 1. Thus, 440 and 880 Hz constitute an interval of one octave. Similarly, 10,000 Hz and 20,000 Hz span one octave.

omnidirectional A term that has come to signify a speaker's ability to spread or disperse the sound evenly throughout the listening area. Strictly speaking, there is no truly "omnidirectional" speaker; a more accurate term would be "multidirectional" or "multiplanar."

peak A maximum instantaneous amplitude in a signal. The opposite of a "peak" is a "dip." The absence of peaks and dips is a desirable aspect of speaker response; an excess of peaks and dips lends an uneven, ragged quality to the reproduced sound. A broad peak or dip covering an appreciable portion of the tonal range can lend an artificial "coloration" to the reproduced sound.

phantom A signal carried by or reproduced through two sources in such a

manner as to "appear" from another source. In two- and four-channel stereo reproduction, sounds which appear to come from between the loudspeakers are said to be "phantomed."

phase A part of a signal with respect to its relative timing vis-à-vis other parts. Phase distortion refers to the displacement of this time relationship. Moderate amounts of phase distortion are said to be objectionable in that they lend the reproduced sound a "canned" quality and detract from the speaker's transient response and its ability to reproduce inner musical detail.

An "out of phase" condition is said to exist when the individual drivers in a multiple speaker system are not vibrating in step with one another; i.e., one is "pushing" while another is "pulling." Two speaker systems, as entities, are said to be "out of phase" when one system as a whole is "pushing" while the other is "pulling." Out-of-phase hookups cause loss of bass tones and a wavering of the stereo image.

power When used in connection with loudspeakers, the term refers to the amplifier power recommended for driving the speaker as well as the maximum amplifier power it is safe to feed to the speaker. The term "acoustic power" refers to the signal output provided by the speaker and is expressed as a sound measurement rather than an electrical measurement.

resonance A tendency for a speaker, while being driven, to emphasize particular tones.

reverberation A slight, tapering prolongation of sounds due to multiple reflections in a large auditorium. It differs from echo, which is (acoustically) a sudden return of sound rather than a smooth decay.

ringing A tendency for a component to continue responding to a no-longer-present signal. See also "damping."

rms Root mean square; the effective value of a signal that has been expressed graphically by a sine wave.

rolloff A gradual diminishing of signal amplitude over a portion of the frequency response.

sensitivity For loudspeakers, this term has the same meaning as "efficiency."

signal Electrical energy generally; in

audio, the electrical replica of intelligence.

sine wave In effect, a pure tone of a single frequency, used in testing and as a carrier wave to be modulated with a signal.

speaker enclosure A structure or cabinet specifically designed to house a loudspeaker in order to load its output to the listening area and to generally aid in its response. A bass reflex system uses a critically dimensioned port (auxiliary opening) to help smooth and extend the bass response. An infinite baffle totally encloses the speaker to suppress its rear wave, thereby permitting the speaker to respond down to its inherent resonant frequency. An acoustic or air-suspension system is relatively smaller than the previous types and uses a very loosely suspended woofer whose resonance is raised to the audible range and whose diaphragm motion is controlled by a critical amount of air trapped within the enclosure. A folded horn adds a constantly expanding horn structure to the front and/or rear of a diaphragm to couple its output, via "acoustic transformer" action to the room. A transmission-line system (actually a variation of the former labyrinth system) loads a diaphragm with a critically dimensioned duct that smooths the response and helps extend the low-frequency range.

A "tower" enclosure describes a speaker enclosure that is designed as a vertical structure in which drivers may be installed in a vertical array, or so positioned as to radiate their energy upward, or from more than one side, etc.

sum The combination of two electrical signals of the same electrical polarity; the total electrical energy produced by combining the two signals of a stereo program. If the two speaker systems of a stereo setup are placed one atop the other, they will produce an "acoustical sum" (monophonic version) of the stereo program.

transient response Ability to respond to percussive signals cleanly and instantly without "ringing."

transmission-line speaker See "speaker enclosure."

tweeter Loudspeaker designed for high frequencies.

woofer Loudspeaker designed for low frequencies.

Z Symbol for impedance, q.v.

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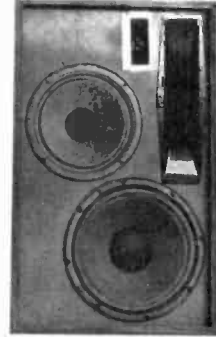
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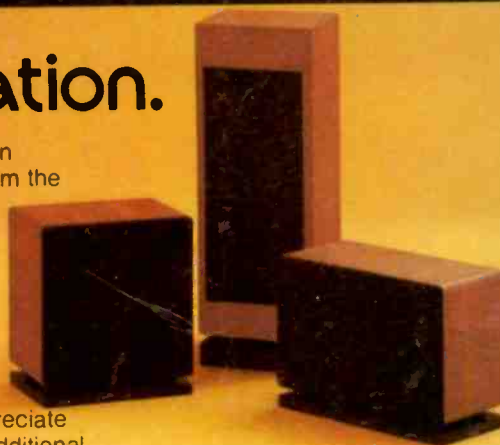
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