


Audio

Scenes—
AES Convention

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • AUGUST 1976 75¢

47425 

Summer
Sound Systems

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Bose 901 Series II

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Audio

August 1976 "Successor to **RADIO** Est. 1917" Vol. 60, No. 8

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About the cover: "Summertime and the livin' is easy..." and what better time to listen to the refrains from that song while under the shade of a cool tree with a picnic lunch awaiting the first pangs of hunger. Loudspeakers are Electro-voice Musicaster IIs, and the models: Gloria Klaiman and David Shockley.



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Before you buy your next turntable, consider why you want a new one.

In letters and warranty cards from new Dual owners, we find that some had owned manual turntables and came to prefer the convenience and safety of automatic start and stop. Others also wanted to be able to play records in uninterrupted sequence. And a few gave reasons that modestly makes us hesitate to quote: "I wanted the best!" or "Everyone recommends Dual!"

Whatever your reason may be for wanting a new turntable, consider your purchase carefully. Your record collection probably represents a bigger investment than all your other components combined. And your turntable is the only component that handles your records.

Although the overall appearance and feel of a turntable's controls can tell you something about its quality, appearances can be deceptive. For example, curved tonearms may appear interesting, but their unnecessary mass and increased resonance can only detract from the quality of music reproduction. All Dual tonearms follow a straight line from pivot to cartridge holder for maximum rigidity and lowest mass.

Some tonearms apply stylus pressure by unbalancing the tonearm. This results in tracking which is adversely affected by record warp conditions and turntable level. In every Dual, stylus pressure is applied around the vertical pivot via a long coiled spring. This maintains tonearm balance throughout play, and tracking is unaffected even if the turntable is tilted substantially.

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Dual 1225.



Dual 1249.



Dual CS701.

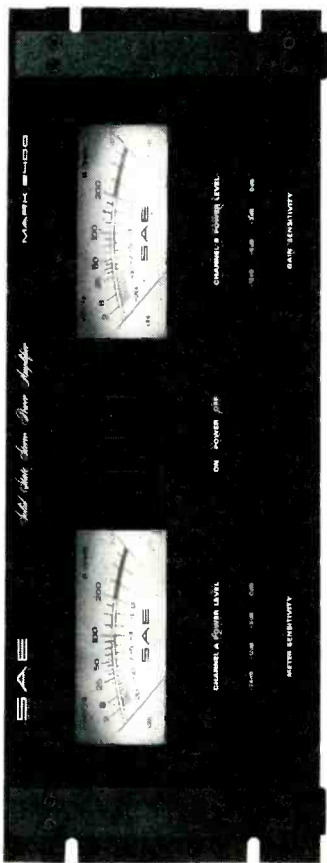
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Audioclinic

Joseph Giovanelli

High Fidelity Amplifiers and Musical Instruments

Q. I have several, old mono tube basic amplifiers of undistinguished lineage. As they are of little use for hi-fi or stereo use, but are still capable of a fair amount of power (12-25 watts) I have been wondering if they could be used for instrument amplifiers, such as for electric guitar and bass.

I have been variously told that it would require a preamplifier or that the input from a guitar would be too strong, requiring cutting into the circuit somewhere or adding some complicated additional circuitry. What is your advice?—Steven Lindblom, Stratham, N. H.

A. Many musicians buy amplifiers which can produce 100 watts of power and up for use with their instruments and your amplifiers are not close to that figure. However, there are a number of small amplifiers designed for musical instruments which do not have any more power than those which you wish to use, so from this standpoint you should be fine.

With the volume of a guitar or electric bass turned up fully, I would estimate that we would get a approximately 0.1 volt of output signal. The actual output will vary over a wide range, depending on the physical effort the performer uses to play the instrument. While this 0.1 volt is more volume than is produced by most microphones, it is not as much volume as is produced by a tube tuner of the sort probably used when your amplifiers were popular. Thus, the musical instrument might not drive the amplifier to full output. The input sensitivity of your amplifier is, therefore, too low.

It all resolves itself to what input voltage, with the amplifier's volume control turned up fully, will produce full output power? If this output is around 0.1 volt, your amplifier may be suitable just as it is. However, if you play the instrument very softly, then perhaps you won't have enough signal to drive the amplifier to the volume level you might like.

In any event, you will not need any sort of circuit which would provide gain reduction, requiring you to cut into the amplifier circuit at some later stage.

What you probably need is some sort of voltage amplifier which will make up any difference between what your amplifier can do and what it has to do in order to be driven to full output. Such devices are available as "power boosters," sold by dealers who sell musical instruments and amplifiers. These devices are small, battery-powered boxes, generally employing one or two transistors. They are much smaller than "fuzz" or vibrato generators, envelope modifiers, octave boxes, and the like.

If these amplifiers do not have their own tone controls, these circuits must be added. The makers of the power boosters also make simple units designed to boost either the bass or treble ends of the spectrum but not both at the same time. These inexpensive elements can be useful to you. Both booster amplifiers and tone controls are sometimes available for as little as \$10.00 each.

High-fidelity amplifiers do not have vibrato or reverb built into them as is the case with many guitar amplifiers. Therefore, you might need to add these devices externally, and units are available for this application.

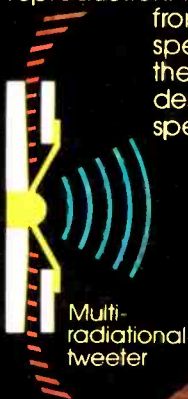
You may find that these amplifiers do not sound just as they should when driven into distortion but this aspect of music is often useful to performers to create an effect. The character of this distortion is different in tube amplifiers from that in solid-state amplifiers. This is the reason that some performers still use tube amplifiers rather than solid-state units. From this standpoint you may be well served by the tube amplifiers you have.

If you have a problem or question on audio, write to Mr. Joseph Giovanelli, at AUDIO, 401 North Broad Street, Philadelphia, Pa. 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

AUDIO • AUGUST, 1976

Look how simple Sansui's new LM speaker design* really is.

Complicated speaker designs very often compound the age old problems of sound reproduction. The end result of complexity is often far from the ideal of clean, crisp sound that a speaker should deliver. Sansui engineers therefore sought simplicity in their new design — the already famous LM series: speakers that can reproduce sound naturally and faithfully and with much greater dynamic range than you would expect in speaker systems of such size.



The LM series feature a new linear motion tweeter design on

which there is a patent pending. This design overcomes the problems of transient and other types of distortion caused by enclosure or encapsulating the rear emanation of sound in an air tight cavity by directing this rear sound energy through three exponential horns thereby recovering and adding the energy to the sound that emerges at the front. Improved transient response, less distortion and a greater sense of stereo perspective are the highly desirable products of this outstandingly creative and innovative Sansui design. With only one crossover, these two way speakers are highly efficient. The musical image is extremely stable with an outstanding sense of presence — almost as if you were at the original source of sound.

Hear the modestly priced LM series — the LM 110, the LM 220 and the LM 330 — at your Sansui franchised dealer today. Listen. They speak for themselves.



LM 330



LM 110



LM 220

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K-240
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Now listen to the AKG K-240 Sextett. Hear the difference. **Six passive (slave) diaphragms surround a main driving transducer** to reproduce in depth the sound of a live performance with a special quality that you've never heard from headphones.



Len Feldman (Feldman Report, *Tape Deck Quarterly*) writes "... the AKG headphones tend to minimize exaggerated and unnatural stereo effects... a listening quality reminiscent of what we hear (with) the very best electrostatic headphones around. Considering cost, that's quite an accomplishment."

And they're light on your head, too. Ultra-soft pads assure virtually no wearer fatigue. Earcups are fitted to the AKG auto-adjust headband. For modest budgets listen to the AKG K-140.

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Herman Burstein

Tape guide

Reverse Delay

Q. *The reverse mechanism of my Concord Mark IV auto-reverse tape deck is triggered by sensing the no-signal period at the end of the tape. The reversing mechanism has a built-in time delay of 7-8 seconds to preclude reversal in the middle of a selection. I find this delay to be insufficient and would like to know if the delay can be increased to 11-12 seconds. Would this be a complex and/or costly adjustment and perhaps one that I could perform myself?*—David Wilson, Newton, Mass.

A. I don't think the change would be difficult. Probably it only involves changing the value of a resistor and/or capacitor in order to obtain a greater time constant. When you locate the time-delay circuit, try experimentally increasing its capacitor by about 50 per cent.

Background Noise

Q. *(1) When my Roberts 770X tape recorder is on, I can hear broadcast stations in the background. What can I do about this? (2) How may I record from my mono cassette into the Roberts and vice versa? (3) What part of my Roberts recorder should I connect to for ground? Should it be grounded to the a.c. outlet or the amplifier ground terminal? I already have my tuner and phono turntable grounded to the amplifier terminal. (4) I want to put conversation on the tape at the same time that I am recording it. How may this be done? (5) In recording from FM and discs, what should be the tone control settings?*—Tommy Allen, Highland Park, Mich.

A. (1) Try a small capacitor (up to about 50 pF) between the first stage input and ground. (2) If your cassette does not have an output jack, take the output signal from across the playback gain control. Take your cassette machine to your local audio store to ascertain what connecting cables and plugs you will require for input and output. (3) I surmise you have a hum problem and have found that grounding helps overcome it. Any screw in the tape recorder chassis would pro-

vide a ground. But one often finds experimentally that some grounding points do a better job of reducing hum than others. Your tape recorder is already grounded to the amplifier via the connecting cable. If you are going to run a separate ground from the tape machine to the amplifiers, this might increase hum. If a separate ground from the tape machine to the amplifier doesn't help, then try connecting the ground to the a.c. outlet (earth) ground. (4) If your tape recorder does not already provide mixing facilities, you will have to acquire a separate mixer in order to combine input sources. (5) Adjust the tone controls according to what your ears prefer. The settings should ordinarily be electrically flat, unless you are trying to compensate for some unbalance in the source material.

Cassette Changes

Q. *For a long time I have been using Scotch C-90 and C-120 cassettes with very good results, but I have had difficulty with them. Upon playback I have found the recording to be fuzzy. Going back to my older cassettes, I obtained the usual good results, confirming that my recorder is not at fault. Thinking that the new C-90s and C-120s might be part of a bad run, I purchased more of these, but the recordings turned out just as badly.*—F. S. Kemp, Sterling, Conn.

A. You may be getting new tape formulations under the old label, perhaps requiring different bias and equalization. In an effort to make the cassette competitive with open reel, there have been rapid developments in tape formulation. Fuzziness may be due to the fact that your machine provides insufficient bias for the newer tapes. ▲

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 401 North Broad Street, Philadelphia, Pa. 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

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DYNAMIC DUO

Power and performance to equal the best, in a new state-of-the-art tuner and amplifier from KENWOOD

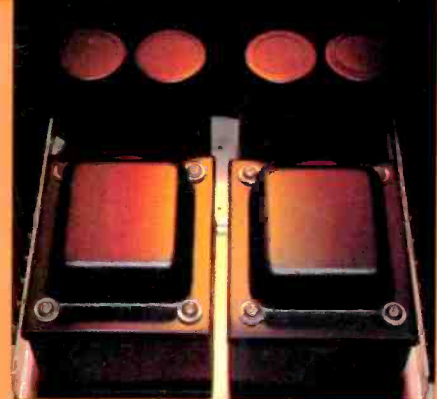


Kt-7300 Stereo Tuner
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KA-7300 Stereo
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RMS, 8 ohms,
20-20k Hz, with no
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An AM/FM tuner so sophisticated FM-stereo reception is brought to new highs of high fidelity. A stereo amplifier so advanced, a complete new concept of audio power unveils the hidden beauty you never knew existed in stereo reproduction. Together the new KT-7300 and the KA-7300 continue the tradition of KENWOOD, bringing you stereo at its finest.

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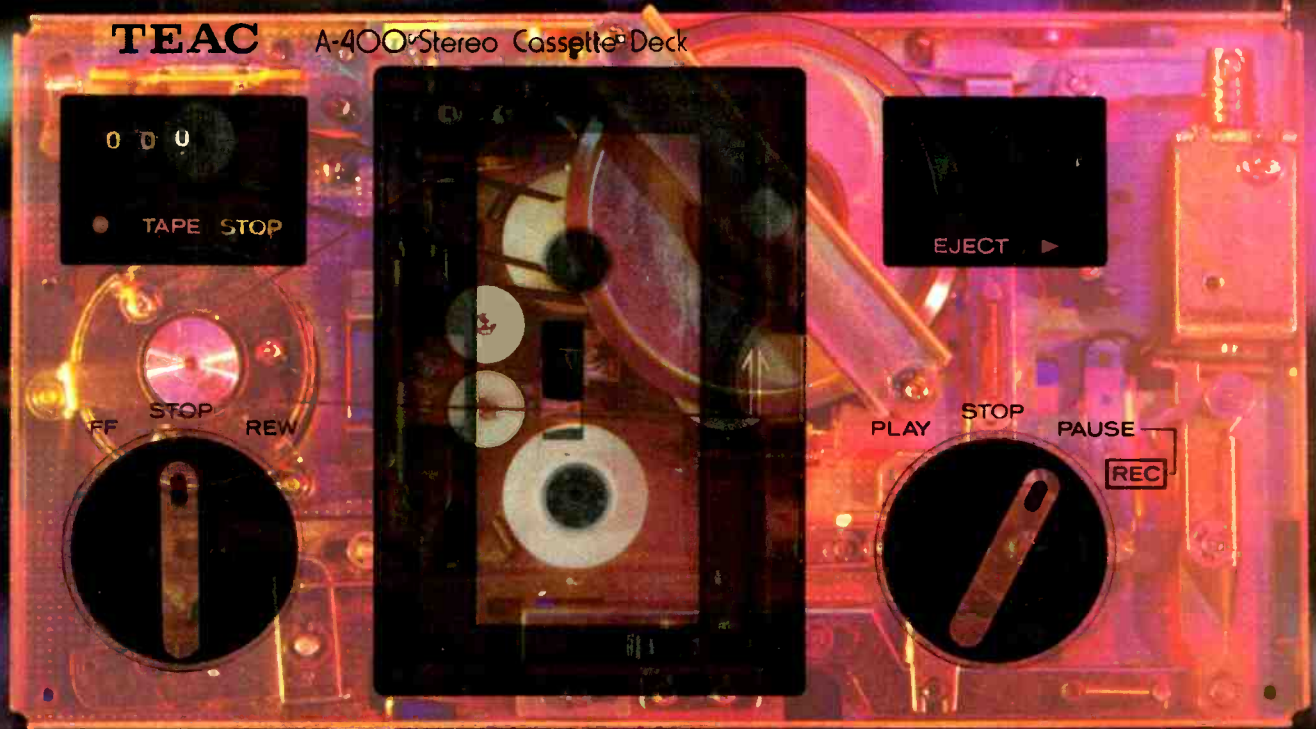
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Twin rotary levers control the transport functions with smooth, positive cam action. Which means unnecessary mechanical linkages have been eliminated. You get peace of mind instead, because fewer moving parts assure greater reliability and long term dependability.

Since the cassette loads vertically into the A-400, the adverse effect of

gravity on the cassette package itself is eliminated. So tape jams are prevented and smooth, even tape packs are predictable.

If new design concepts superbly executed appeal to you, put an A-400 through its paces. Just call (800) 447-4700* toll free for the name and location of your nearest TEAC retailer. You'll find that the A-400 delivers definitive TEAC performance with the added convenience of a front load component. All by design.

*In Illinois, call (800) 322-4400.

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Audio etc.

So the single inventory comes to America in a big way! Columbia Records. Last December, you will remember, I made a strong pitch for this strategically useful integration of the quadraphonic disc into "regular" lines (stereo) as an absolute necessity if we were to save the whole of the quadraphonic biz, software, hardware and all. Last autumn, that British giant, EMI, one of the largest record makers and an early SQ licensee, suddenly dropped its Columbia-style dual release system—a quadraphonic disc and another beside it for stereo—and went over to a single release, thus building its quadraphonic into the "regular" record line. From thence onwards EMI discs have appeared as stereo/quadraphonic, SQ encoded, or as plain stereo, unencoded, according to need and judgment; no

Lo!—now it *has* happened. The first of our major record producers to go over to the single-inventory on its own. (Capitol/Angel, you understand, is the American arm of EMI.) True, some canny small labels had already seen the light and got there first. But their tails couldn't wag the big dog. (His Master's Voice is an EMI trade mark.) I mean the *American* dog. Columbia is that dog, or a large hunk of him.

Henceforth, then, there will be only one Columbia release for each catalogue item. As at EMI, it will be stereo/quadraphonic or stereo, to choice, at one price either way. No more deluxe extra-cost quadraphonics, no more duplicate releases. If there is SQ, and there will be, it will be totally integrated, right on the regular record at the standard

Four-Channel Software

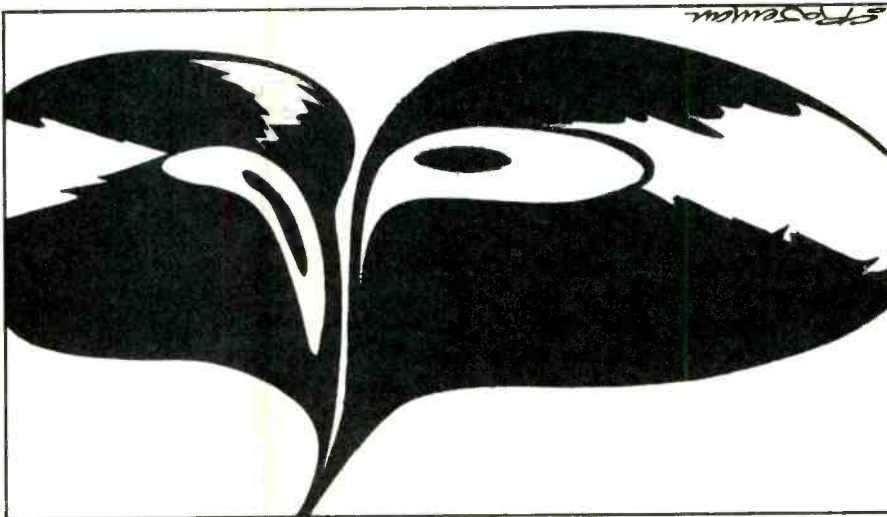
This is the *only* way to project that new system into "the" system, the one point at which we can really integrate the new and the old, right down the line. Because where the disc goes, so goes the rest of quadraphonic. The disc is the first source, the greatest source, the mass source for software; it's also the seed, the sprout of an idea, the first contact for new audiences, new distribution. Quadraphonic *equipment* can only follow.

And so I find Columbia's decision extraordinarily sensible. Because, at some sacrifice—an unpleasant internal reorganization, a lot of pride swallowing—the change could end the past painful history of the quadraphonic disc, which has tottered on now, year after year, neither a failure nor really a success in the face of competing setero, always on the verge of extinction as unprofitable, equally on the edge of a real expansion and prestige. The thing just *has* to go one way or the other. And as the disc goes, again, so goes quadraphonic, the works. Major companies the world over have adopted quadraphonic on disc. Other major companies have ignored its existence, at least in public. A waiting game. Now maybe we'll see. Columbia's move is surely the beginning of the end and it could be a positive ending.

Let me say again that via the single release quadraphonic is taking the traditional road to a place in record history, as have all previous radical innovations that have been absorbed into the mainstream. We have always returned, after new changes, to the single form of record though for awhile there may have been several parallel and (maybe) compatible versions.

Only a genuine *difference in content* has ever allowed an alternative release form to survive for long. That includes, of course, such diversities as the 45 record and the numerous LP repackagings now available. Note that the 45 disc is still with us, but the 45 *album*, directly paralleling the LP, quickly died. History says emphatically that on disc we *will not accept two forms of the same content* for

10



price difference and the stereo/quadraphonic, the *only* release of the material, serving as *the* stereo record. A daring move, since it exploited the much vaunted "compatibility" to its total conclusion as the dual system certainly did not.

Silent Indecision

Well, the reaction over here, for all anybody could say, was nil. A deafening silence. Our big companies plodded right along towards their quadraphonic doom, just as if nothing had happened. Discouraging. But these things take time. I seem to have been onto the right message.

price. Now, everybody will be buying SQ who buys Columbia records.

Those record stores which have (reluctantly) set up special separate quadraphonic boutiques or whatever, with whole separate stocks of quadraphonic records, now can joyfully begin to dismantle them—joy is what I would expect, anyhow. They'll sell many more quadraphonics without extra space needs, minus extra effort. A lot more important, those myriads of stores which have never bothered to get into any quadraphonic at all will now find themselves automatically selling SQ, perhaps to their own surprise. Amazing grace!

TDK SA. WE DEFY ANYONE TO MATCH OUR VITAL STATISTICS.

Manufacturer	Brand	MAGAZINE A		MAGAZINE B	
		S/N Ratio Weighted in dB	Output @ 3% THD	S/N in dB (re: 3% THD)	THD at 0 dB (%)
TDK	SA	66.5	+4.2	66.0	0.9
AMPEX	20:20+	56.4	+1.9	—	—
FUJI	FX	60.0	+2.3	—	—
MAXELL	UD	—	—	58.5	1.1
MAXELL	UDXL	62.5	+2.7	—	—
NAKAMICHI	EX	60.0	+2.3	55.0	1.1
SCOTCH	CHROME	—	—	64.0	1.3
SCOTCH	CLASSIC	62.5	+2.0	—	—
SONY	FERRICHROME	64.0	+2.1	64.0	1.8

Decks used for tests: Magazine A-Pioneer CT-F9191 (cross-checked on DUAL 901, TEAC 450); Magazine B-NAKAMICHI 1000.

11

Two leading hi-fi magazines working independently tested a wide variety of cassettes. In both tests, TDK SA clearly outperformed the other premium priced cassettes.

The statistics speak for themselves. TDK SA provides a greater S/N ratio (66.5 dB weighted and 66.0 dB @ 3% THD), greater output sensitivity (+4.2 dB @ 3% THD), and less distortion (THD 0.9%) than these tapes.

When you convert these statistics into sound, TDK SA allows you to play back more of the original signal with less distortion and noise.

Put these facts and figures together and TDK SA adds up to the State of the Art because it provides greater dynamic range. This means cleaner, clearer, crisper recordings, plain and simple. Sound for sound, there isn't a cassette that can match its vital statistics.

Statistics may be the gospel of the audiophile, but the ultimate judge is your own ear. Record a piece of music with the tape you're using now. Then record that same music at the same levels using TDK SA. You'll hear why TDK SA defies anyone to match its sound.

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Stravinsky . . . and every composer who has ever written music with the range, power and majesty of "Rites of Spring" . . . music that demands far more than any stereo can deliver without adequate amplifier power.

12

The Phase Linear 700B Power Amplifier faithfully reproduces the most difficult passages of the most demanding recorded music. It lets *all* of the music through at realistic volume levels. You never have to reach for your volume or tone controls to prevent clipping.

The 700B has the highest power, widest frequency response and lowest distortion of any stereo amplifier in the world. Take Stravinsky to your dealer and listen to what we mean.



Phase Linear 700-B

THE POWERFUL DIFFERENCE

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more than a trial period. True, quadrasonic is a somewhat special case, for it will not supplant stereo but, rather, supplement it and live beside it. All the more reason, you see, for a single type of record to meet both needs! And with the price difference removed, and that fluid inter-compatibility, the disc playable either way, quadrasonic will be carried right along, *wherever the disc may go*. You don't have to play four ways. But you always can. You might want to try . . . one of these days. Nice set-up, yes?

Tape & Radio

Ummm-umm. So you have reservations. Let me try to answer them. Is the disc that important? Does quadrasonic really depend on it? There's always tape. And radio. Could not quadrasonic survive well enough with their aid?

As for tape, in theory it is the ideal medium since it accommodates four totally discrete channels with no trouble at all. But as we know, there are peripheral problems which tend to become central. Tape hasn't yet put any form of disc out of circulation. In a sense, it has simply expanded the disc market, into new places, new outlets, using basically the same original material. It has not anywhere replaced the disc, if by that you mean that there is no disc version. Not beyond the peanuts stage, anyhow.

Reel-to-reel tape, even four-way, is obsolescent, rightly or wrongly, a very thin reed on which to base expensive equipment. The easier, cheaper plug-in tapes run into cost problems, still, and their clumsiness in manufacture is no match for the easily multiplied and distributed disc (which still maintains its averaged-out quality edge). They run into procedural difficulties, on the one hand, and technical limitations, on the other. Yes, we might maintain a very modest all-tape quadrasonic market, but would that be enough? Not really. Maybe for autos via Q-8. Not the home.

As for radio, curiously, it also is basically an adjunct to the disc as far as listening to recorded material is concerned. We get our disc sound in two ways, either on our own home players or over the air via radio's turntables (or via taped equivalents—the argument isn't changed). Radio is a useful alternative for consumer listening—to whatever is available in recorded form.

But what *is* available? I can only say that if there were no quadrasonic discs, there would be precious few quadrasonic broadcasts—via any

system. Minus disc, I do not think quadrasonic on the air can be sustained, any more than via tape, not to mention the necessary home equipment. Everything is tied, eventually, into the disc. For now. Maybe later something different. Not yet.

FCC Delays

Also, as of now, we have only the two matrix types of broadcast quadrasonic, QS and SQ, fighting it out as usual but actually reasonably inter-compatible in the listening, on the air or at home. Other broadcast systems hang. The F.C.C. deliberates. Which system? No CD-4 until the F.C.C. finishes its deliberations and even then it might come out with some other way. An even thinner reed, this one, for any industry to lean upon, through nobody's fault in particular.

So, back to the disc. With its solid support, tape goes along very well and so does radio. Quadrasonic broadcasts of the allowed types are, as the produce market puts it, in considerable supply. Live pickups are a heady supplement to recorded material. Things are going well in radio. But the disc remains the economic pillar that holds it all together. And there is that ever-more-important quadrasonic enhancement of stereo sound, which may be had just as easily via broadcast as via home playing.

For a long time I've been saying that the biggest innovation in the quadrasonic area in terms of musical significance is this variable enhancement of millions of existing stereo recordings into a four-way sound that is often startlingly superior to the stereo effect out of two speakers. "Now more than ever!" as the ads say. Improved and sophisticated logic decoders, new special enhancement circuits designed to give a maximum four-way impact to the partially random separations inherent in the stereo disc. This thing has taken on a big importance as a part of the quadrasonic scene—but, oddly, minus the quadrasonic disc itself. A big importance but not a total one. Even the real four-way improvement of the stereo disc is not enough by itself to sustain an equipment market, simply because via any of the systems the true quadrasonic disc gives a more precise and less random control over four playback channels. And thus, potentially, its effect is always better than uncontrolled randomness, however inspiring. It's as easy as that. We need the *quadrasonic* disc. Same old message. And we also need stereo on disc. NOT separately. One line of discs, for

Acoustic Research AR-11

The world's best speaker?

An outstanding new AR speaker gives the state of the art a shot in the arm

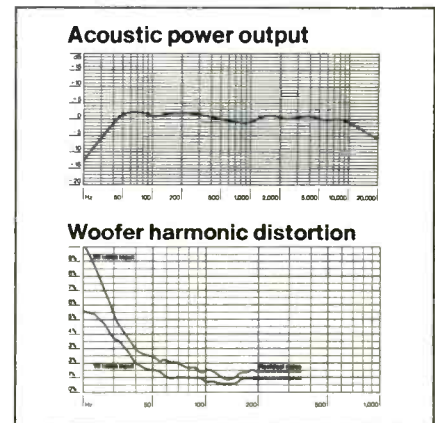


AR speakers have always been considered the standard of the high fidelity industry in just about any price category the company cared to field an entry. From the original top-of-the-line AR-1 to the incredible AR-7, which set new standards for loudspeakers of diminutive size, it has been AR speakers against which all others were judged by reviewers, by competing manufacturers, and by the public. Now, after seven

years, a new standard has been introduced at the top of the AR line, and the State of the Art is advanced another notch.

The AR-11 is the most accurate speaker system ever made by Acoustic Research—which means that it is a very likely candidate for the most accurate loudspeaker *ever*. Its main advance over earlier AR speakers is its ability to produce 'flat energy response' in virtually any listening room. This means simply that music played over a pair of AR-11s is clear, transparent, and razor-sharp, not only in one listening location, but practically anywhere in the room. Whatever is contained on the record, radio broadcast, or tape is accurately transmitted to essentially all listeners.

And of course AR is still the master of the acoustic suspension woofer principle, which we introduced to the public way back in 1954. For lifelike, bone-rattling bass when it should be there, and no interfering coloration when it shouldn't be, AR speakers are still the ones to beat . . . and the AR-11 is the best of the lot.

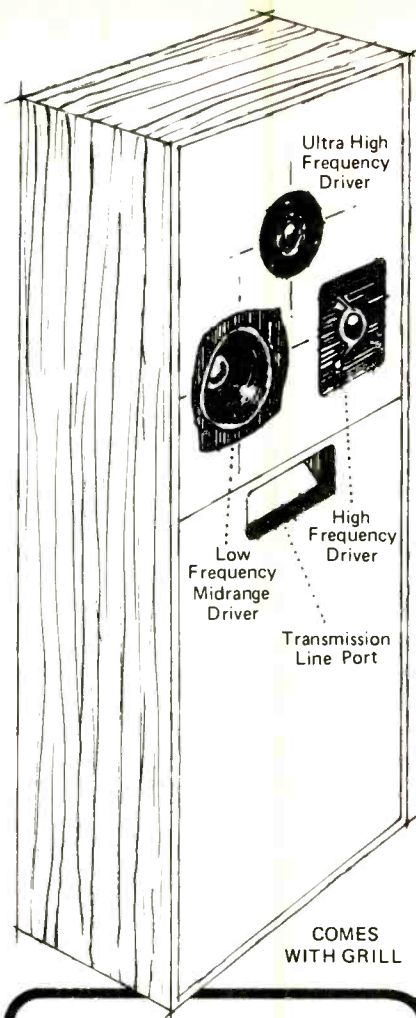


Accuracy is what high fidelity is all about. Loudspeakers in particular, of all hi fi components, find this ideal goal especially elusive. But the AR-11 does bring it one step closer, and for that reason its introduction is one of the most significant events in recent audio history. It has to be heard.

Additional information can be obtained directly from Acoustic Research:

Acoustic Research
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Norwood, Massachusetts 02062





COMES WITH GRILL

14

Innotech: Radical design, exceptional performance

Unlike conventional models, our Transmission Line and Bass Reflex speakers permit accurate reproduction of the "transient" information in all music. This, combined with wide & linear frequency response, plus low distortion, gives Innotech speakers an uncanny accuracy in reproducing music and other sonic inputs; all pitch and tone nuances are accurately portrayed.

A dynamic piston-type cone woofer/midrange driver is uniquely combined with dome-type tweeters in a phase-coherent array. The woofer has a 5 inch plastic cone capable of long movement without breakup. The motor size of this woofer is extremely large for a cone of such low mass and size. Thus, the woofer reproduces all frequencies in its range with accurate transient definition.

The dome tweeters and super-tweeters also combine low diaphragm mass with large motor size to yield accurate frequency and transient information. Drivers are front-mounted and positioned as closely as possible. By utilizing a unique crossover design with these clustered drivers, Innotech speakers generate an integrated, phase-coherent, sonic wave front with a wide dispersion pattern.

Innotech speakers are an advancement from the current state-of-the-art, a step closer to being "at the performance." Write for details.

innotech™

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all purposes. Otherwise—no quadraphonic at all.

Stereo/Quadraphonic Sound

Now about the degree of sacrifice implied by this joint stereo/quadraphonic record as now promoted. We will soon have concrete material for test. We will hear for ourselves via Columbia's new output. Not A-B! There won't be any A-B comparison since there will be but the one release. So we must, and should, judge simply by over-all results. Do we notice any degradation in the quadraphonic product? (And, maybe, is the stereo aspect in any noticeable way compromised, as we listen?)

I strongly doubt it. With so many other variables, the wildly different forms of music, mike techniques, hall acoustics, performances, the vast latitude in editorial mixdown from multi-track originals, 99 per cent of us will find that the hypothetical compromises in the stereo/quadraphonic discs, played either way, are lost in the general shuffle. We will be happy with what we get, in either mode, four or two, or we will be unhappy but for some other and more usual reason—music, acoustics, recording balance and so on.

Yes, there are compromises that must be made, variably, as the special Columbia SQ team that put forth the separate SQ records must now ruefully be saying. Some of our ears, those that are honed to hear sound first and music second (and that is plenty of us) will perhaps notice differences, aberrations from the ideal best stereo, or best quadraphonic. I am not one of these people myself; I hear music first, though I can detect the hi and the fi when I have a mind to. Some damage done, admittedly. But in the over-all the stereo/quadraphonic record, via any of the existing systems, is not a major compromise in the artistic sense. We can live with it. We can make it grow, too.

After all, I must say once more, there are still choices, there is emphasis. We may well shift over, as we go on, from stereo towards quadraphonic until we end up exactly where we have been before—a quadraphonic disc that will also play stereo. And we must understand that the techniques of the joint operation are in flux and will quite inevitably improve—for more of both, better stereo and better quadraphonic. (Remember when we made stereo and mono discs separately, with quite different techniques? We merged them, out of necessity, into the stereo/

mono all-purpose disc. We haven't really suffered.)

Whether we can tolerate compromises or not is beside the point. The point is SURVIVAL. With the single-inventory combined disc, even with variants for all three present operating systems, all of which do have the potential for stereo compatibility (as they so often tell us), we will establish a much broader and bigger base for the rest of the quadraphonic industry. So that, now, we can at last begin to expand away from the esoteric, the complicated, the prohibitively expensive, into much wider areas and on down into that no-man's land, that every-man's-land, the "trade" biz.

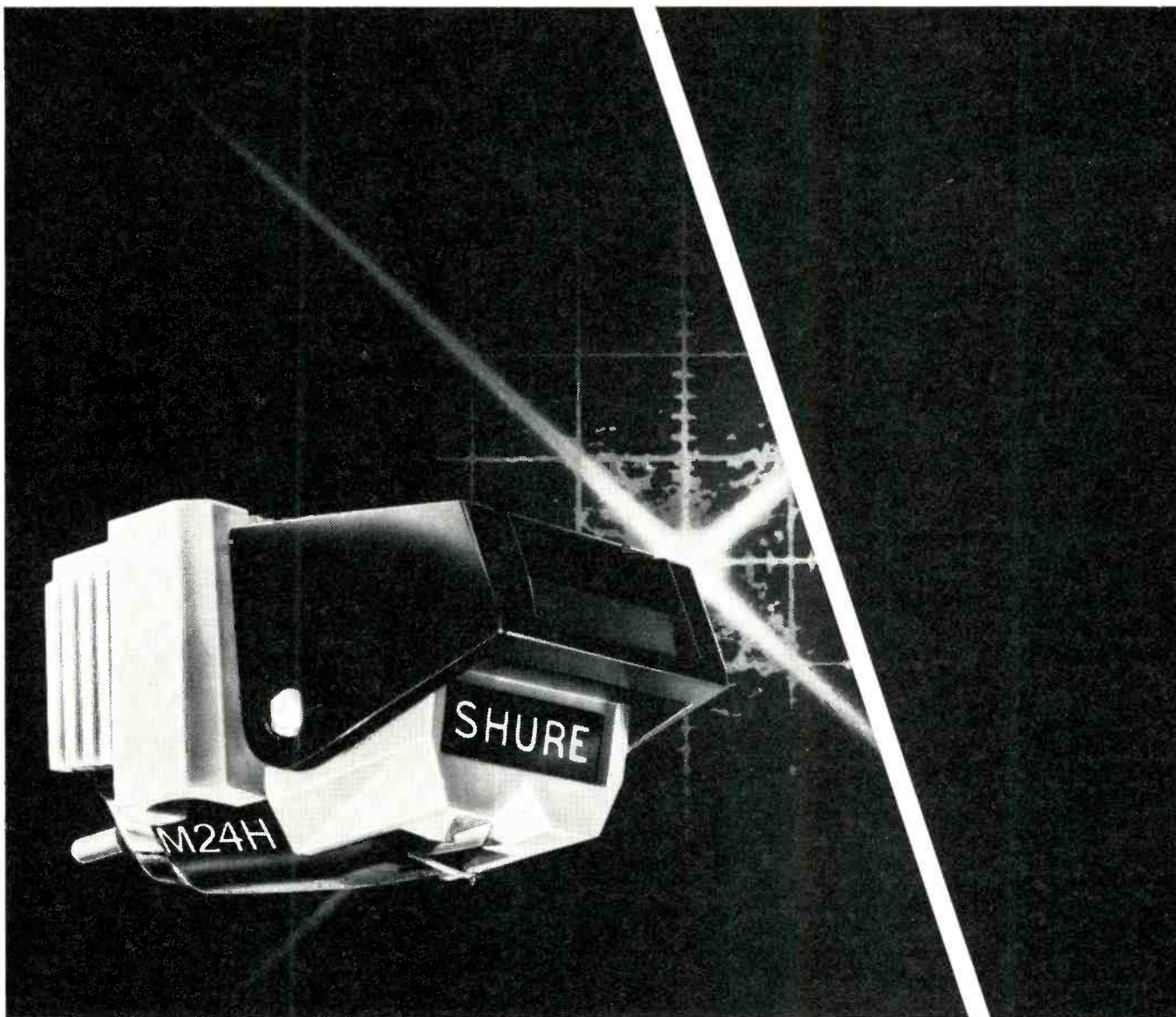
What a dismal scene, there, from the quadraphonic viewpoint! Stereos galore, hundreds of them, thousands, mostly looking just like their granddaddies in hi-fi componentry and a lot of them not bad, all things considered. Every last one of them brings some sort of stereo sound to a buyer. And not a quadraphonic anywhere. Just try any big department store or radio/TV outlet. Look in Sears Roebuck and Montgomery Ward. Nothing.

No—we won't take quadraphonic quite down to the grisly mass bottom. But we can now take it a lot further than before, *much* further, what with quadraphonic discs, marked that way right on the label and the cover, going out to unheard-of new areas all over the place, and just asking to be played. "You saw it on TV"—the perennial come-on. Well, now you saw it on the record you bought. Didn't you? Maybe I'm crass, but I know this works, and I won't forget that the lowly cheapie supports the high-bred hi fi. More than ever.

Prognostications

Ah yes, those comparisons I was going to make between the quadraphonic disc systems, back in May. Deliberately, I didn't. Because at that time every feeler inside me said *look out—something is going to happen* and it'll change everything. And so it has. Now, you see, we re-evaluate all the systems in the light of the single-repertoire spreading-out of quadraphonic software. But it's early. At least for me, writing here. Remember, I'm back in the day before yesterday. What about RCA—has it jumped? Maybe you know but I don't. Is London standing put, or staying put? What about the big import labels—will they join up? We shall see—that is, I shall see. You probably know already. **A**

AUDIO • AUGUST, 1976



Uncompromised stereo/quadrphony —Undeniably Shure.



The new Shure M24H Cartridge offers audiophiles the best of both worlds: It is the only cartridge on the market that does not compromise stereo reproduction to add discrete quadriphonic capability. It eliminates the need to change cartridges every time you change record formats! This remarkable performance is achieved at only 1 to 1½ grams tracking force—comparable to that of some of the most expensive conventional stereo cartridges. Other M24H features include the lowest effective stylus mass (0.39 mg) in quadrphony, a hyperbolic stylus tip design, an exclusive “Dyneric® X” exotic high-energy magnetic assembly, and a rising frequency response in the supersonic carrier band frequencies that is optimized for both stereo and quadriphonic re-creation. If you are considering adding CD-4 capability, but intend to continue playing your stereo library, this is the ONE cartridge for you.

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Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

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Behind the scenes

As most readers are aware, the Audio Engineering Society holds three conventions each year...one in Los Angeles, one in New York, and one in a European city. Three conventions per year for an industry is an extraordinary fact in itself, and frankly, there have been some rumblings that this is overdoing things a bit. Yet the field of audio is so dynamic, with research going on all over the world, and with an ever expanding input of new technology, that these conventions are well supported. The AES as an organization is enjoying phenomenal growth. In this country and abroad, new sections (chapters) are constantly being formed, and as a glance at the Journal of the AES will verify, each month shows a healthy influx of new members.

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As I have noted before, the excitement quotient of AES conventions varies...they are never less than interesting, but now and then one comes along that is fairly bursting with new ideas and technology, innovative and even revolutionary professional audio equipment. The 54th AES convention, held May 4th through 7th at the Los Angeles Hilton, generated just that sort of pizzazz.

Technical Treatises

As always, there are interesting papers presented at the technical sessions. I should point out that reprints of these papers are available from the AES in New York at a modest cost. For a list of papers, write to the AES at 60 East 42nd St., New York, N.Y. 10017. At the risk of slighting many fine papers, I found particularly intriguing #1131, "A Time Align Technique for Loudspeaker System Design," by Ed Long, and #1115, our own Dick Heyser's mind-blowing dissertation on what he calls "Holomorph Recording." Don't ask me to explain...can't be done in a few words...but it is a far-out concept and well worth reading about. In keeping with the trend at recent AES conventions, seminars on pertinent audio subjects were presented. At the 54th, it was David Klepper and Stan

Miller on Sound Reinforcement, and Big John Woram of the Institute of Audio Research on Echo and Reverberation, and Compressors and Expanders.

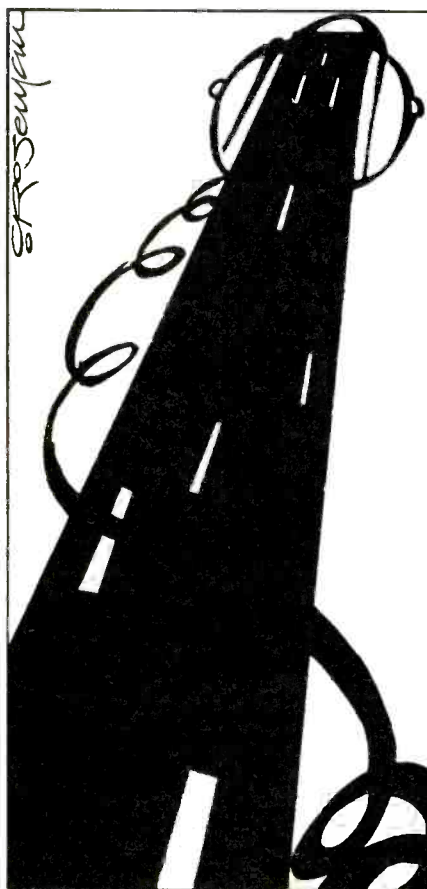
As usual, the exhibit areas of the Hilton were crammed with the new, novel, and nifty versions of every conceivable kind of professional audio equipment. There was the usual plethora of portable mixers, consoles everywhere, with computerized mix-down facilities more and more in evidence. Rupert Neve made a big splash in this respect with a system in which the control pots are physically positioned from information in the stored program. Automated Processes was showing its Model 1024 programmer which uses a digital data cartridge to

store programming information and has over 1000 control channels. Good Heavens! To think I used to record Woody Herman and Stan Kenton with two (count 'em) microphones directly into the recorder!

The big multi-track studio recorders, with up to 24 channels, appeared with new models from Ampex, MCI, Scully, Studer, and Stephens. The Ampex MM1200 accepts up to 14-in. reels, as do some of these other machines, and this size appears to be a growing trend. There were new microphones from Shure, Sennheiser, and AKG, and Electro-Voice introduced a wireless microphone system. New multi-purpose test instruments were shown by Sound Technology, Amber Electro Design, and Tektronix. I am happy to say that UREI is now into production of its Model 200/2000 automatic frequency response plotter, and I should have one by the time you read this. Needless to say, there were scads of other interesting new equipment, but I must get on to the items which made this 54th AES convention so memorable.

"Idealized" Recorder

Ampex held a press conference just before the convention opened and bowled us over with the totally unexpected introduction of a fabulous new tape recorder, the ATR-100. In my opinion, and the opinion of many of the audio press fraternity, the ATR-100 was that overworked but apt term "the hit of the show." The ATR-100 is not one of the massive multi-track recorders using 2-in. tape. It is available from mono full-track and two-track stereo on quarter-inch tape on up to four channels on half-inch tape. Quite simply, the ATR-100 represents the distillation of years of input from engineers in the field, as to what they would like to see in an "idealized" tape recorder. Given virtually, free rein, Ampex engineers spent better than three years on the design of the ATR-100. Here are some of the details of this new recorder...For a start, the ATR-100 has no pinch roller! Both reel



THE TAPE THAT'S TOO GOOD FOR MOST EQUIPMENT.

Maxell tapes are not cheap.

In fact, a single reel of our most expensive tape costs more than many inexpensive tape recorders.

Our tape is expensive because it's designed specifically to get the most out of good high fidelity components. And unfortunately, there's not much to get out of most inexpensive tape recorders.

So it makes no sense to invest in Maxell unless you have equipment that can put it to good use.

And since even a little speck of dust can put a dropout in tape, no one gets into our manufacturing area until he's been washed, dressed in a special dust-free uniform and vacuumed.

(Yes, vacuumed.)

Unlike most tape-makers, we don't test our tape every now and then. We test every inch of every Maxell tape.

Which is why every Maxell tape you buy sounds exactly the same. From end to end. Tape to tape. Year to year. Wherever you buy it.

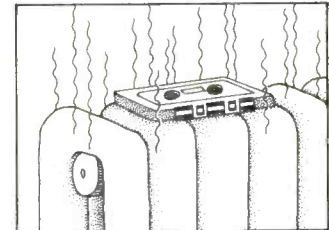
And Delrin rollers. Because nothing sticks to them.

A lot of companies weld their cassettes together. We use screws. Screws are more expensive. But they also make for a stronger cassette.

Our tape comes with a better guarantee than your tape recorder.

Nothing is guaranteed to last forever. Nothing we know of, except our tape.

So our guarantee is simplicity itself: anytime you ever have a prob-



Our guarantee even covers acts of negligence.

Give our tape a fair hearing.

You can hear just how good Maxell tape sounds at your nearby audio dealer.

(Chances are, it's what he uses to demonstrate his best tape decks.)



No other tape starts off by cleaning off your tape recorder.

No other tape sounds as good as ours because no other tape is made as carefully as ours.

For example, every batch of magnetic oxide we use gets run through an electron microscope before we use it. This reveals the exact size and proportions of individual particles of oxide. Because if they're not perfect, the tape won't sound perfect.



Every employee, vacuumed.

We clean off the crud other tapes leave behind.

After all the work we put into our tape, we're not about to let it go to waste on a dirty tape recorder head. So we put non-abrasive head cleaning leader on all our cassettes and reel-to-reel tapes. Which is something no other tape company bothers to do.

Our cassettes are put together as carefully as our tape.

Other companies are willing to use wax paper and plastic rollers in their cassettes. We're not. We use carbon-impregnated material.

lem with any Maxell cassette, 8-track or reel-to-reel tape, you can send it back and get a new one.

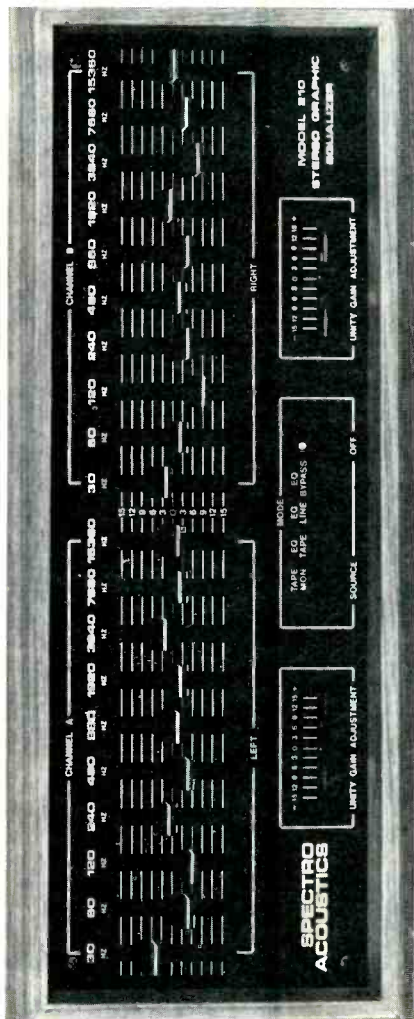
You may be surprised to hear how much more music good equipment can produce when it's equipped with good tape.



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TUNE UP



18

MODEL 210 Suggested Retail \$295*

GRAPHIC EQUALIZER

The Model 210 can be used to "fine tune" any sound system for the ultimate in definition and clarity. Room, speaker and recorded material variations can often "gobble up" or over-emphasize certain audio frequencies. Authoritative tight bass, open highs, brassy horns and smooth solos are all in their place with the 210's individual octave energy controls . . . all without adding any audible noise or distortion. To wit:

- Less than 0.01% IM distortion
- Over 100 dB dynamic range
- 600 ohm outputs drive any system
- Free five year service contract

PLUS long throw silicone dampened controls for better accuracy, gyrator synthesized inductors for ultra-low distortion, full switching facilities for EQ line/tape/bypass and tape monitor, as well as full range unity gain level adjustments. The 210R Rack Mount version is also available.

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motors and the single drive capstan are servo controlled and employed in a closed-loop servo system which maintains constant tension at each reel in all operating modes. Through built-in digital computer logic, the ATR-100 is programmed to control the movement of the tape by adjusting the tape tension so that it is equal on each side of the capstan. It senses the motion of the capstan, in which direction it is moving, and recognizes the size of the heads and width of the tape, then automatically adjusts the tension. With constant tape tension, the machine can handle any reel from two to 14 inches in diameter. The ATR-100 operates at 3 3/4, 7 1/2, 15 and 30 ips, and any combination of two speeds can be selected at one time. The ATR-100 can rewind a 2400-ft. reel of tape in 60 seconds. While at a blistering 500 inches per second in fast forward mode, if you depress the play button, dynamic braking takes over, the tape slows rapidly, does not stop, but smoothly locks into the play mode speed. There is a control panel which looks like and is about the size of a pocket calculator. It is replete with LED indicators for various functions, along with push-buttons for tape motion control, and wonder of wonders, an electronic tape timer with illuminated digital readout in hours, minutes, and seconds (or minutes, seconds, and tenths) accurate to within plus or minus a half second with a 2400-ft. reel. The entire control panel can be moved to the left of the machine, so left-handed engineers finally get a break. In a distinct departure for Ampex, the heads are all ferrite of a new type. Along with a special record circuit, we finally have a recorder with multi-track heads which is phase coherent. . .there is no phase distortion and square waves can be recorded. Ampex is quoting a wow and flutter spec of NAB unweighted at 15 ips of ± 0.04 per cent, frequency response of 20 Hz to 20 kHz ± 2 dB at 15 ips, but within the band from 100 Hz to 15 kHz, it is ± 0.75 dB. Signal-to-noise ratio, ANSI "A" weighted, is stated as 73 dB for multi-track and 15 ips NAB equalization. THD is quoted as 0.3 per cent at 0 VU @ 1kHz, and IM is 1.0 per cent @ 0VU. Mighty impressive to say the least. There is, of course, a great deal more to this new Ampex ATR-100 tape recorder than this brief run-through. I hope to get my Irish mitts on one of these machines in the not too distant future, and then bring you a full in-depth report.

Delay Acoustics

If the Ampex ATR-100 was widely lauded as an item of equipment, then Acoustic Research must be given kudos for the sensational experiment and demonstration they conducted in their soundroom on the fourth floor of the Hilton. Billed as a "16-channel, programmed delay network," it is, in essence, a method of electronically simulating concert hall acoustics which can be added to the reproduction of ordinary stereo records. I think this development is one of the most significant audio advances in recent years, and I want to give in-depth coverage to it and explore its many fascinating ramifications. That will be in a forthcoming column, so my description at this time will necessarily be brief. A Hewlett-Packard 9821/9862 calculator-plotter computer was used to compute a mathematical model of the acoustic properties of a concert hall (in this case, Boston Symphony Hall) which provided the data to set the controls of a 16-channel digital time-delay system. Sixteen segments of a hemisphere in the hall have their characteristic early reflection patterns and, of course, differing time delays. In the AR room, presided over by Bob Berkovitz and David McIntosh, the research people on this project, there were a pair of standard AR 11 speakers in normal stereo configuration, and then on the front, side, and rear walls, a total of 16 AR-7 speakers, each driven by its own 10-watt amplifier. There was also a standard pre-amp/amplifier driving the AR 11 speakers, and AR turntable for record playback. The digital delay network has 16 individual pots for setting delay levels to each of the 16 amp/speakers. It should be stressed that this is not a reverb system, and time-delay simulation is only possible when the recording contains decay information. Since most engineers strive to record hall ambience in classical recordings, such recordings work very well with this system. Recordings with "dry" acoustics will have a strange "outdoor" sound on this system. Given a good classical recording (Bob used an excellent Janacek choral recording), you hear it "straight" through the AR 11 stereo speakers, and then when the 16 channels of time delay are switched in, the effect is simply staggering. The walls of the listening room do indeed "fall away," and you are hearing the music as it would sound if it were being performed in Boston Symphony Hall! The realism is simply breathtaking. Needless to say, other speak-

AUDIO • AUGUST, 1976



Bring home a legend.

When you go out to buy a stereo system, you'll be matching sophisticated, expensive components from a vast array of choices.

More important (because good music means a lot to you), you'll be selecting an important part of your personal environment.

So you don't want to be let down, not even a little bit. That's why the speakers you bring home should be Bose 901s.[®]

You'll be impressed with your new 901s as soon as you unpack them. They're much more compact than their performance, reputation, or price would lead you to believe, and they're beautifully crafted from fine materials.

By the time you have the system set up, you'll somehow be expecting something new and better in the music, something you've never been able to hear before.

You won't be disappointed.

You will hear an extraordinarily open, spacious sound that very effectively reproduces the feeling of a live, concert-hall performance, a sound that has been acclaimed by reviewers all over the world.

That unique sound is the result

of several interrelated technical developments.

First, the 901s are Direct/Reflecting[®] speakers. Sound reflects off the walls of the room, surrounding you with the correct proportions of reflected and direct sound, all frequencies in balance, almost everywhere in the room. In contrast, conventional direct-radiating speakers tend to beam high frequencies, limiting optimum listening area, and producing a sometimes harsh sound.

Second, the 901 has no conventional woofers or tweeters, just nine identical, 4½-inch, full-range drivers, acoustically coupled inside that very compact 901 cabinet. Coupling tends to cancel out, across all nine drivers, the small imperfections found in any speaker (ours included). The result is a smooth, life-like sound that's virtually free of distortion.

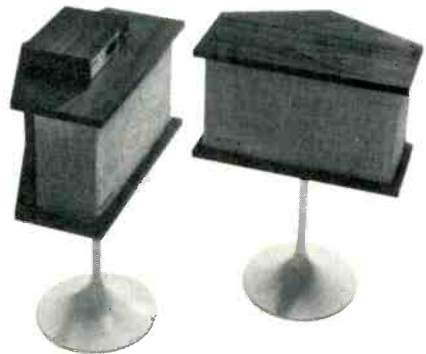
Third is the Active Equalizer, a compact electronic unit that automatically boosts power at frequencies that need a boost. This produces consistent sound output up and down the frequency range, with full, clear highs and solid, powerful lows.

The first time you listen to

your new 901s, you'll know you've brought home the right speakers. Years later you'll have the continued satisfaction of owning and using a product of uncompromising quality.

We invite you to go to a Bose dealer, listen, and compare the 901 to any other speaker, regardless of size or price. Then you'll begin to know why the Bose 901 has become something more than a loudspeaker system for thousands of music lovers all over the world.

For a full-color brochure on the 901 loudspeaker system, write: Bose, Dept. AU7, The Mountain, Framingham, Mass. 01701. Patents issued and pending.



BOSE[®]

The Mountain
Framingham, Mass. 01701

ers can be used for the normal stereo pair if you don't dig AR, and the same holds true for the delay speakers. However, considering the small energy content in each channel, and the non-coherent nature of the sound, the little AR7s seems well suited for this system, and from an aesthetic viewpoint, their size is an advantage. Everyone who heard this demonstration at the convention was mightily impressed, and what had started out as an experiment, now appears to be shaping up as a product. Plans call for a simplified "domestic" version and a model of the "all-out" system. Once again, this shows the great interest in acoustic enhancement by means of time delay and is why equipment to accomplish this is coming on the market. One of these is the Sound Concepts unit, a bucket-brigade delay device, the other is a real digital-delay unit from a firm called Audio Pulse. I expect to have an Audio Pulse unit before long, and we'll give it a whirl.

Quadraphonic Front

On the quadraphonic front, JVC was flying the flag for CD-4 in a demonstration room on the ballroom floor of the Hilton. CD-4 expert John

Eargle was on hand and was showing a new JVC demodulator, which had all the usual goodies like PLL, etc., but in addition had a new "noise gating" system which works only on the high frequency carrier. With this in the circuit, the noise level of conventional stereo records and the noise levels of CD-4 recordings are now equal. With CD-4 records cut with the new JVC Mark-3 cutting system or its RCA equivalent, the "Quadulator," plus this new noise-gating circuit, the sound quality of CD-4 records can be outstanding. A case in point is a recording of the music from the film "Jaws," which John played for me. While this recording was made in Hollywood by MCA, it was cut and distributed in Japan and is not available here. (Although if enough people bug JVC, they might make it available.) The sound quality on this CD-4 recording is not only exemplary for this medium, but rivals anything heard on a stereo record. It had plenty of level; deep, solid bass, and an amazing dynamic range. Some of the fortissimo passages will blow you out of your seat. All in all, a stunning recording job and, as played through properly set up CD-4 equipment, proves this medium has come of age.

Certainly, the sound I heard in the JVC room was among the best at the convention.

Stereo AM

Finally, mention must be made of the demonstration of AM stereo by Sansui. Sansui is the proponent of two different methods of broadcasting AM stereo, with other systems proposed by RCA, Motorola and several others. These systems are being evaluated by a committee formed to investigate the feasibility of AM stereo. In Sansui's preferred embodiment, an AM-AM system, mono transmissions become a carrier and single side-band and uses only half of the presently available band. This would also permit compatible QS AM broadcasting. All I can tell you is that in an actual closed circuit transmission in the Sansui room, both systems worked well, and we were listening to what was undeniably stereo AM.

Highlight of the AES Banquet Thursday evening was a performance by the internationally renowned Roger Wagner Chorale with a repertoire of folk, popular, and semi-classical tunes for a fitting finale to this year's Los Angeles Convention. A

20

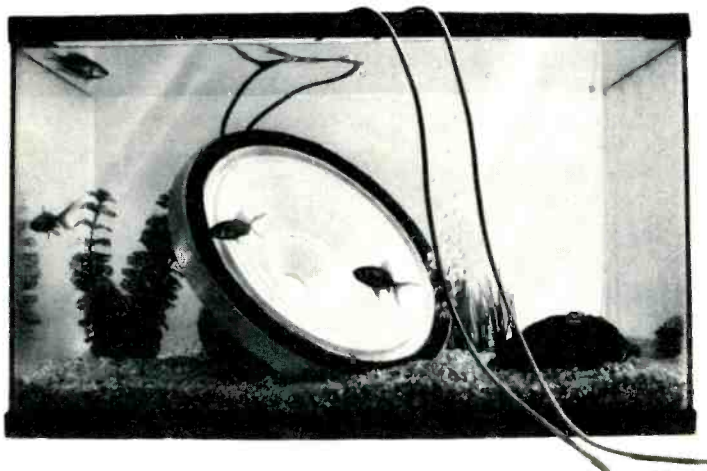
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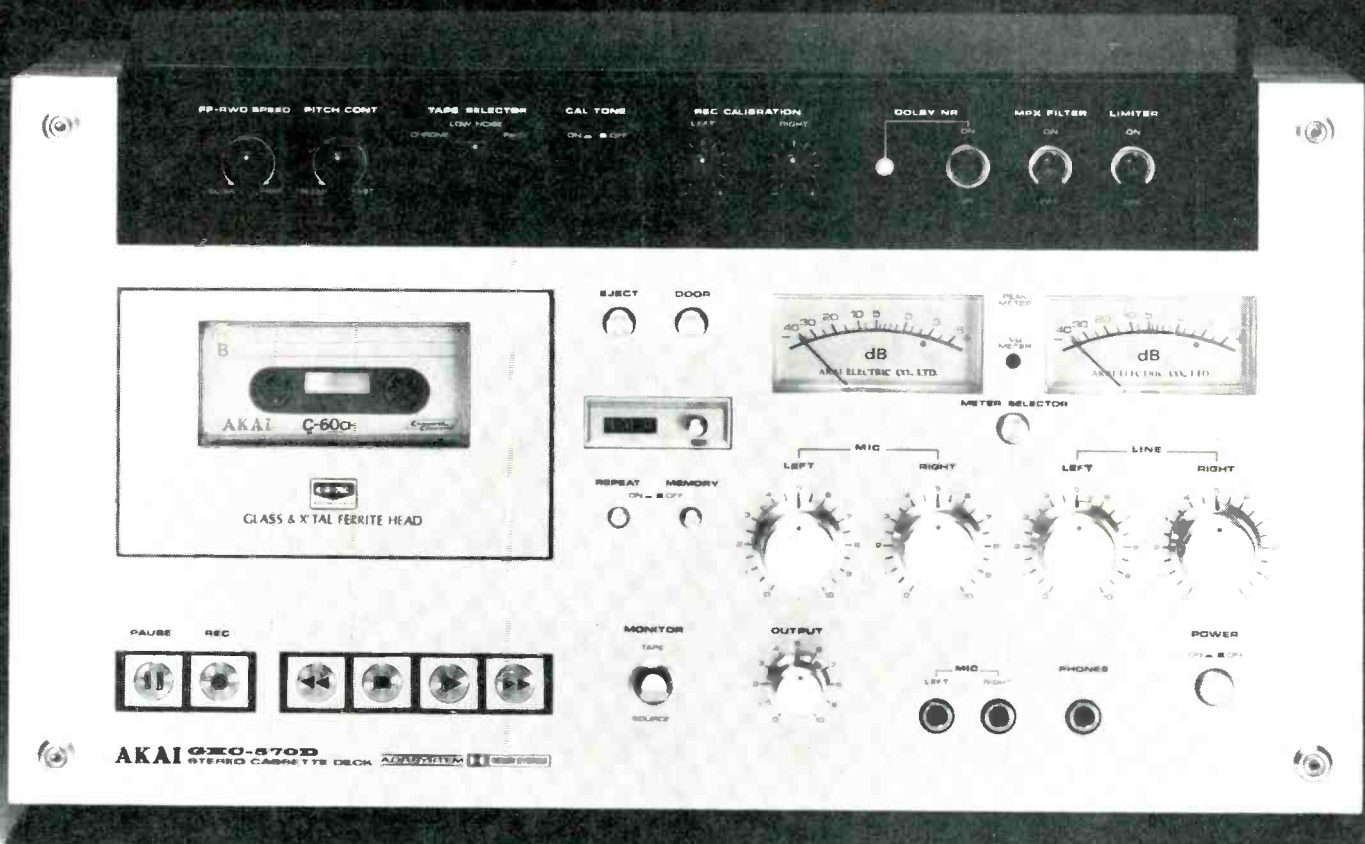


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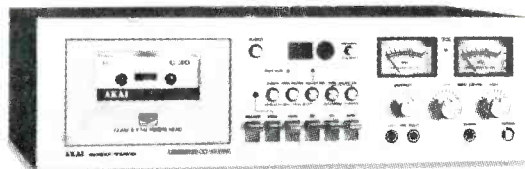
It utilizes a 3 head recording system — a GX glass and crystal combination head so you can source monitor when recording and, if you don't like what you've got, an erase head.

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Summer Sound Systems

Glen M. Ballou

Sound amplification has become as common in our life as Coke, and rightfully so. People should not be required to concentrate on listening to the sound, but should be able to concentrate on absorbing the message.

Sound-reinforcement systems range from those designed to cover 100,000 people and costing more than \$250,000 to a small system to cover 20 people and costing \$250. Public address or PA systems are usually limited-response, inexpensive sound-reinforcement systems. PA systems do, nevertheless, have their place and are very necessary for the small "picnic" type sound systems where ease of installation and operation are very important.

Every system, no matter what size, must satisfy four basic parameters:

- 1—They must be loud enough.
- 2—They must cover the entire audience area.
- 3—They must be able to be understood.
- 4—They must be capable of performing all functions the customer requires.

This article will cover the above parameters and their solutions for the small "picnic" type outdoor PA systems.

Loudness and Coverage

It is often said of PA systems, "It was so loud it hurt my ears" while another person might say of the same system, "It was so soft I couldn't make out what he said." One of the most difficult problems encountered in outdoor "picnic" PA systems is the ability to make the system loud enough everywhere without making some areas excessively loud and the entire system distorted. This is usually best corrected by placing the speakers properly and by using high efficiency speakers with good projection patterns.

Unfortunately, all outdoor PA systems must follow the laws of physics, and such phenomena we cannot change. One of these laws is known as the "inverse square of sound attenuation," which states every time the distance is doubled, the sound pressure level (SPL) is reduced 6 dB or to 1/4 of the reference sound intensity.

Outdoor PA systems require more power than indoor systems to produce a specific SPL at a specified distance. This is because outdoor systems very closely follow the "inverse square law" while indoor systems get help from reflections from the side walls, floors and ceilings to a point where, at D_C (critical distance) and beyond, apparent level remains constant. Critical distance is defined as the distance where direct and reverberant sound are equal in level, often 8 to 20 ft. in the average room.

Because the inverse square law is followed outdoors, a speaker 4 ft. from an observer must produce an SPL of 110 dB to give a SPL of 76 dB at 200 ft. A level of 76 dB is the minimum level one should accept at the maximum required distance as 70-dB SPL is a fairly common noise level where the "picnic" type PA system is used. A 110-dB SPL is the same level as standing one foot from a man's mouth when he is shouting, while 76-dB SPL has the same level as being 50 ft. from the same shouter.

This difference in SPL between any two points can be determined by using the graph of Fig. 1. To determine the difference in SPL between any two distances, locate the differences in Fig. 1, go vertically to the diagonal line and then horizontally to the attenuation. Subtract the near distance attenuation from the far distance attenuation for the difference between the two. To determine this mathematically, see the appendix.

Let us assume that d_F is the farthest

distance the loudspeaker must project and d_N is the closest distance the loudspeaker will project to. Raising the speaker in the air and moving it away from the audience does not appreciably increase d_F ; however, it does increase d_N substantially as in Fig. 2. Raising the speaker 4 ft. and moving it back 4 ft. changes d_N from 4 ft. to 9 ft. while only changing d_F from 200 ft. to 204 ft. With an SPL of 110 dB at 4 ft. from the speaker as before, the front of the audience area will be 103-dB SPL or the same level as 2 ft. from the shouter and the rear of the area will still be 76-dB SPL.

Raising the speaker to 12 ft. and moving it back 12 ft. changes d_N to 20 ft. and d_F to 212 ft. This would mean with 110-dB SPL at 4 ft., the front of the audience area SPL would be reduced to an SPL of 96 dB or a level equivalent to 4 ft. from the shouter, while the rear of the audience area would be 75.5-dB SPL.

As can be seen, this position of the loudspeaker only decreased the d_F SPL 0.5 dB, while decreasing the d_N 14 dB. A difference in level of ± 10 dB subjectively sounds about one-half or twice as loud as the reference sound. In an outdoor system a Δ SPL of 4 dB would be ideal, however, 15 to 20 dB is acceptable as long as the system is being used for announcements, etc., and not as a sound-reinforcement system for high-quality music amplification.

Raising the speaker higher will reduce the SPL difference between the front and rear of the audience area, however methods of mounting and effects of wind and temperature on sound limit useful height to about 20 ft.

Once we have determined the relative acceptable levels between the front and rear of the audience area, we can determine the power required to drive the speakers. To do this, we

must know the speaker's sensitivity and horizontal and vertical dispersion and the coverage angle required to cover the audience area.

Published speaker coverage angles or dispersion vary from a 60 to 120° circular coverage pattern (Fig. 3) to a rectangular pattern from 20 × 40° to 60 × 120° (Figs. 4 & 5). Unfortunately, sound waves are not all that easily controlled and the angle decreases as the frequency increases (Fig. 6). As can be seen, it is not uncommon for the dispersion angle of the speaker to vary from 220° at 200 Hz to 20° at 10 kHz. The dispersion angle is often given at 2-3 kHz and, therefore, for even coverage to 5-6 kHz, additional speakers are required.

It is very unusual, in outdoor systems, to require a large vertical coverage angle as the audience is usually either standing or sitting on ground level. Speakers with rectangular dispersion have an advantage over speakers with a circular or square dispersion for two reasons:

1—Outdoor sound has no precise boundaries, therefore, any sound which is not absorbed in the audience area is apt to project to unwanted areas (neighbors, etc.).

2—A driver which has the ability to produce a specified SPL into a sphere (omnidirectional) will have a much higher SPL when projected into a portion of that sphere. This translates to less required power input. This is described in the appendix.

We know that we require an SPL of 75 dB at 212 ft. Most speaker manufacturers rate their speaker sensitivity at either 4 or 10 ft. with one-watt electrical input power. Assuming the speaker sensitivity rating is at 4 ft. and we require an SPL of 75 dB at 212 ft., the speaker therefore must deliver 110 dB at 4 ft. This can be determined by adding the dB attenuation for d_f as found in Fig. 1 to the SPL required at d_f . In our example, using Fig. 1, go vertically from 212 ft. to diagonal line, then horizontally to attenuation of 34-dB SPL. Add this to the required SPL at 4 ft., i.e., 34 dB + 76 dB = 110 dB SPL.

Unfortunately, doubling the speaker power does not increase SPL by 6 dB, but only 3 dB, hence it is important, when running outdoor systems (often on battery), to use efficient speakers with controlled dispersion. If the manufacturer's speaker rating was 99 dB @ 1 W at 4 ft. and we require 110-dB program SPL at 4 ft., our Electrical Power Required to the speaker (EPR) would be 12.6 watts of program power (see appendix).

All signals, with the exception of

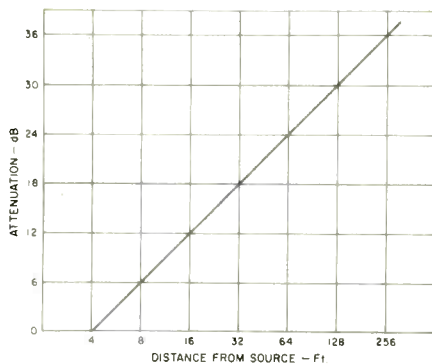


Fig. 1—Inverse square law attenuation of Sound.

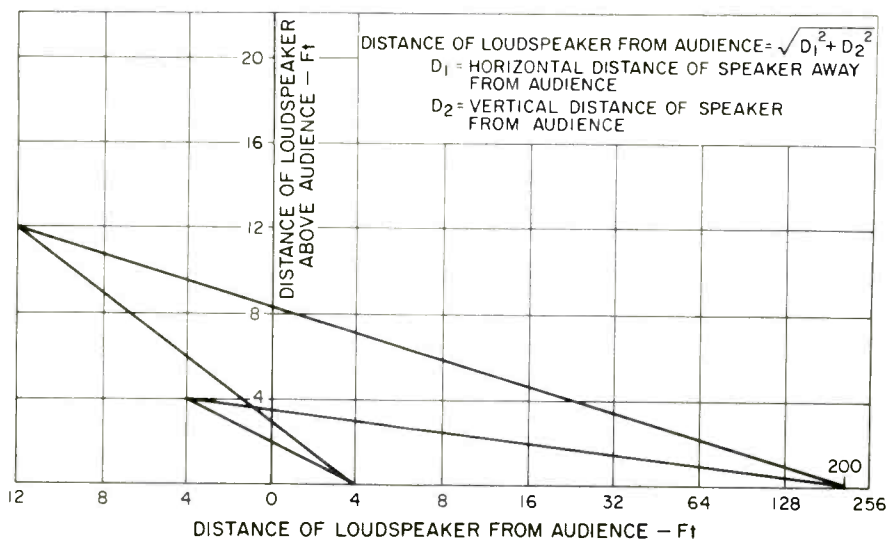


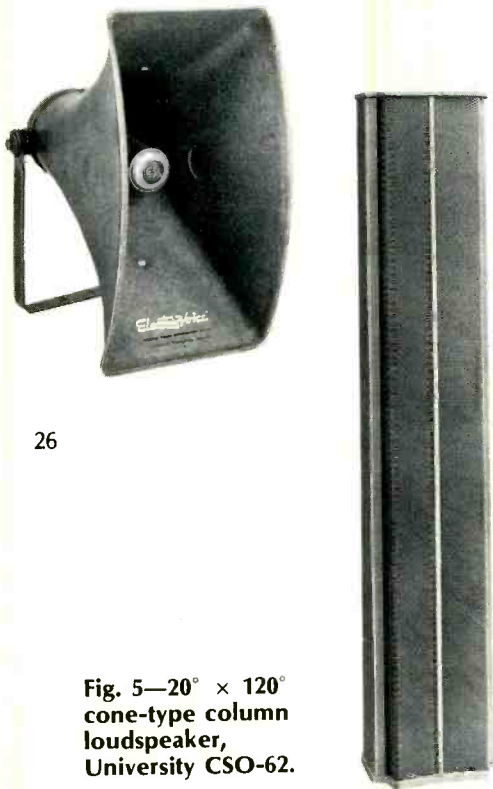
Fig. 2—Effect of moving the loudspeaker away from the audience.

Fig. 3—90° circular dispersion horn speaker, EV AR-150.



pure sine waves, have a crest factor. This means that the peaks of the signal are much higher for a given average power than if it were a sine wave. A crest factor of 10 dB or 10 times is common, therefore, the EPR of the amplifier for 12.6 watts of program power would be 125 watts (see appendix). Many paging horn loudspeakers have a sensitivity of 107 dB or

Fig. 4—70° × 100° rectangular dispersion horn speaker, EV FR-150.



more. This would reduce the EPR to the speaker to 2 watts program or 20 watts total.

Often the required coverage is much larger than the area covered by one speaker, therefore, more than one speaker is required to cover the area. The published speaker dispersion angle is that angle where the acoustical output is 6 dB down from the output on the speaker axis. To insure uniform coverage, the speakers must have at least 20 per cent overlap. If the speakers are stacked and splayed, rather than mounted side-by-side, the frequency response will be more uniform (Fig. 7).

Solid-state amplifiers can become very unhappy when the load impedance is less than the specified output impedance taps of the amplifier. If more than two 8-Ohm speakers are used, it is preferable to use the 70-volt output common on the pro amplifiers and 70-volt transformers on each speaker. This also allows level adjustment for each individual speaker. If four or five speakers are always used and wired in parallel, the speakers can be connected between the 8-Ohm and 16-Ohm taps of the amplifier with only a small loss of power. Since solid-state amplifiers require very little idle power, 10 watts for a 25-watt amplifier and 20 watts for a 100-watt amplifier, it is advisable to use a 60- to 125-watt amplifier for most "picnic" PA systems. This and efficient speakers guarantee adequate volume so it may be heard over the background noise.

Articulation

It is often said "The system was plenty loud, but I couldn't understand a thing he said." This condition is more prevalent in indoor systems

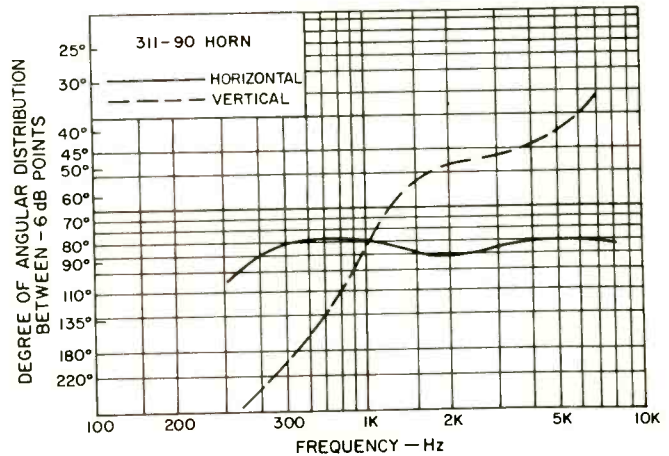
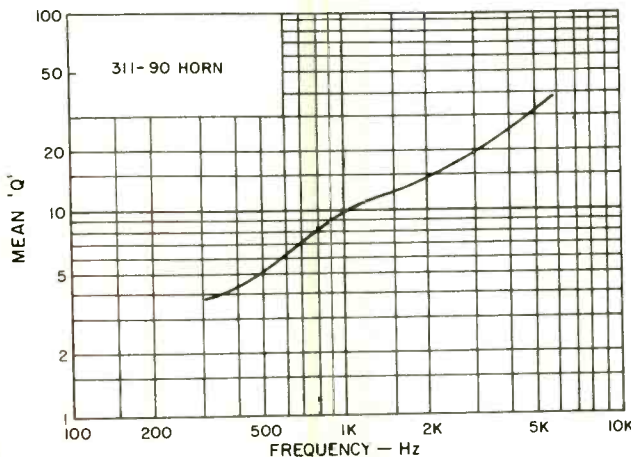
where reverberation is an important factor affecting articulation. Outdoors, reverberation usually does not affect articulation, however, echo, poor signal-to-noise ratio (S/N), distortion, and poor frequency response can all affect articulation. In the reverberant areas, a required S/N of 25 dB is not unusual. In outdoor installations, where reverberation is minimum, a S/N of 3 to 6 dB is usually adequate, however, 6 to 10 dB would be preferred. In fact, the fantastic computer in our head can separate the signal from the noise when the S/N is less than 0 dB.

Echo affects articulation two ways, by increasing the noise level and by adding confusion. A good way to better understand this type of confusion is to talk over the PA system while listening to yourself over a speaker placed 110 feet away. Since sound travels approximately 1,130 ft./sec., it takes 0.1 seconds for the sound to travel back to the talker. When talking over such a system, the talker usually slows down to give the sound time to catch up to him which, of course, it can't do. Next, move the speaker 40 feet away and normal talking can be resumed. Therefore, never have speakers more than 40 feet apart and the first speaker of a string of speakers more than 40 feet from the talker.

Inexpensive microphones, amplifiers, and speakers often have distortion exceeding 10 per cent. Under ideal conditions, 10 per cent distortion is probably acceptable as far as articulation is concerned, however, when S/N is borderline, 10 per cent distortion could increase the articulation loss beyond acceptable limits.

Since most amplifiers have low distortion (2 per cent) and good fre-

Fig. 6—Speaker coverage angle & Q of Altec sectoral horn.



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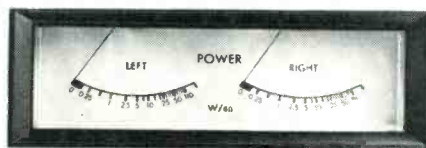
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Approximate retail value of the S600 is \$750.

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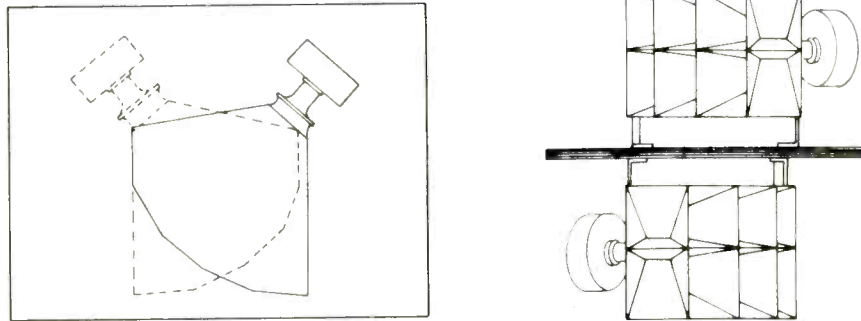
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Fig. 7—Proper method of increasing horizontal dispersion.



quency response (50 Hz to 10 kHz \pm 2 dB), they are not usually the problems in PA systems. Components which change acoustic energy to electrical energy (microphones) and electrical energy to acoustic energy (loudspeakers) are the hardest to make acceptable and require the expenditure of more time and money.

Frequency response of 300 to 3500 Hz, with a peak at 3000 Hz, may be ideal for telephone communications where a broad frequency response would create poor S/N because of long unshielded lines. The narrow frequency response is also acceptable

Microphones

There is always much discussion on the pros and cons of cardioid and omni-directional microphones. In outdoor systems, where the acoustic field is not reverberant, cardioid microphones will increase gain before feedback, particularly when the back of the microphone faces the loudspeaker. A second advantage of the cardioid microphone is that it can be used to discriminate between signal and noise. The heart-shaped pickup pattern of the microphone means that the talker or signal must be directed towards the front of the microphone, not towards the side or rear, and that the rear of the mike should be towards the unwanted sound or noise. Talking into the side of the mike would reduce output about 6 dB, while talking to the rear would reduce mike output up to 20 dB.

All microphones should have an "on-off" switch so the announcers can turn the microphones off when not in use, reducing noise and allowing personal conversations to be carried on in the vicinity of the microphone. For a simple one-microphone system, the Shure SM82 microphone with built-in preamplifier and limiter can be used directly into a power amplifier, bypassing low level preamplifiers and reducing susceptibility to noise, etc.

Outdoor PA systems are susceptible to electrical interference (radio stations, hum, ignition, etc.) because of poor grounds, or lack of grounds, along with the lack of external shield-

ing from building structures, so all microphone inputs should be low impedance and balanced to eliminate noise pickup and allow long microphone lines.

Required Functions

Now that the system is designed to work well (a microphone input gives good quality speaker output), we must make the system do what the customer wants it to do. It is common to require battery power in portable outdoor systems. Many solid-state amplifiers are ideal for operating on battery power as they operate on a 14 V d.c. or 28 V d.c. power supply. This means they can easily be powered by 12 V auto batteries of 12-24 V Ni-Cad batteries. The advantages and disadvantages of automotive lead-acid batteries and Ni-Cad batteries are as follows:

Lead Acid Batteries Advantages

- 1—High power capabilities (5-10 amperes for 8 hours).
- 2—Easy to obtain.
- 3—Can be connected in series for higher voltage.

Disadvantages

- 1—Heavy.
- 2—Cannot be tipped.
- 3—Require large connectors.
- 4—Require maintenance.

Ni-Cad Type Batteries Advantages

- 1—Small.
- 2—Lightweight.

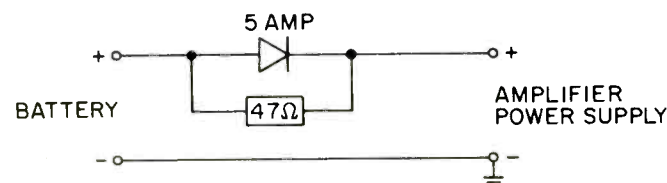
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Fig. 8—75 W amplifier with battery operation and charge capabilities, Altec 1607A.

because conversation is usually short. In outdoor PA systems, this frequency response is not acceptable because the aggravation it produces causes the audience to block their ears to the system, reducing articulation. While the stereo enthusiast would prefer a frequency response that is flat from d.c. to infinity, it is not practical for small outdoor PA systems. What is important is to be able to reproduce some of the lower fundamentals of the male voice, 250 Hz minimum (100 Hz would be better) and to reproduce up to 6 to 8 kHz to assure proper reproduction of the sibilance of the speech, i.e. S's, Z's, etc. Using speakers with a relatively smooth response of 250 Hz to 8 kHz assures fairly good reproduction of the voice and at least acceptable reproduction of background music.

Fig. 9—Battery operating and charging unit.



Size isn't everything



Japan. Land of the audio giants. Companies like Pioneer, Sony, Yamaha. Each with 100 times more engineers, production efficiency, research facilities, marketing resources, and sales — than your average good-sized U.S. or U.K. manufacturer.

November 3rd, 1975, Prince Hotel, Tokyo. The scene of a hallmark event — the 5th annual Japan Stereo Components Grand Prix Contest. An occasion which has indeed become the Grand Prix of the Japanese audio scene. Stereo components from Japan, the U.S., the U.K., and Europe — to be judged on the basis of performance and design by eight famous Japanese hi-fi journalists. Among the entrants: a small speaker, the UL6, recently launched by a not-so-big company: Celestion of England.

January 1976 — the results. **AMONG ALL THE ENTRANTS, WORLDWIDE AND JAPANESE — ONLY ONE SPEAKER WINS THE GRAND PRIX: CELESTION'S DIMINUTIVE UL6.**

Surprising? Not really. All the engineers, efficiency, marketing and money in the world are not sufficient to build a great speaker. Intangible resources are needed: experience, intuition, and dedication. Resources which Celestion has more of than any other speaker company in the world.

Since 1924, Celestion engineers have dedicated themselves uniquely to one art — that of building great speakers. And to doing it all by themselves — from scratch.

Starting from the outside, we see that styling is a special feature of the UL6, with beautiful dark walnut finish on all sides — even on the front baffle-board which is normally concealed by the grille. The grille consists of a slim frame carrying two stand-off ribs to give a three-faced appearance when the black, acoustically transparent cloth is stretched over it.

Now for the guts. UL6 deploys the new HD1000 ultra-wide dispersion 1" dome tweeter, a new Celestion mid-bass unit with massive magnet system and specially treated Bextrene diaphragm, and a new ABR (auxiliary bass radiator) which extends bass response, raises sensitivity and reduces distortion to negligible limits. These advanced precision components were totally researched, designed and built by Celestion to optimize overall performance in the UL6. The result is clean, tight, smooth response from 35 Hz-28 kHz. Performance so superlative that we realistically predict that UL6 will become the reference standard for bookshelf-size speakers.

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Disadvantages

- 1—Ampere-hour ratings indicated are not for one hour, but 20 hour discharge, therefore, a 4.5 ampere-hour battery will supply 0.225 amperes for 20 hours or 4.5 amperes for 30 minutes.
- 2—Internal impedance very low, therefore, battery can be destroyed by shorting.
- 3—Batteries left on shelf for long periods require exercising to bring back their full capacity.

Many amplifiers have a built-in battery charging circuit (Fig. 8), however, those that don't, can have one easily installed. All that is required is a power rectifier which is forward biased when operating on battery, in parallel with a power resistor which charges the battery when the amplifier is operating on a.c. power (Fig. 9).

Amplifiers should have a minimum of two low-impedance microphone inputs, as many outdoor PA systems are used for entertainment along with general paging. In this day of small, battery-operated, cassette tape recorders, it is also important to have an auxiliary high impedance input. All inputs must have their own volume controls.

Summary

Now that we have looked at the problems of outdoor PA systems, does it mean we must go through all the preceding formulae every time we install a portable PA system? By all means, no; however, by knowing the problems and their solutions we can, through our own logic and good judgment, purchase and install outdoor "picnic" type sound systems with improved quality and articulation.

By following these *do's* and *don'ts*, acceptable outdoor "picnic" PA systems can be installed.

Do

- 1—Have adequate amplifier power.
- 2—Use efficient speakers.
- 3—Use speakers with rectangular dispersion.
- 4—Mount speakers in the air and

Appendix

1—The difference in dB SPL between any two points can be determined by the following formula:

$$\Delta\text{SPL} = 20 \log \frac{d_F}{d_N} \text{ where} \tag{1}$$

d_F = far distance
 d_N = near distance

Subtracting ΔSPL from the near distance delivers the SPL at the far distance and conversely, adding ΔSPL to the far distance gives the SPL at the near distance.

$$\text{SPL}_F = \text{SPL}_N - \Delta\text{SPL} \tag{2}$$

$$\text{SPL}_N = \text{SPL}_F + \Delta\text{SPL} \tag{3}$$

2—The formula for determining the SPL of a sphere is:

$$\text{SPL} = 10 \log \left(\frac{W Q 10^{12}}{4\pi r^2} \right) + 10.5 \tag{4}$$

W = acoustic watts
 Q = directivity factor
 r = distance from source

Using $W = 1$ watt
 $Q = 1$ (omni directional)
 $r = 4$ ft.

The maximum SPL = 107.47 dB SPL

Q is the directivity factor or the ratio of the area of a window on the sphere to the entire surface area of the sphere. The average speakers have coverage angles between 1° -180° and, therefore, their Q can be determined by the formulae:

Rectangular Dispersion

$$Q = \frac{180^\circ}{\text{Arc Sin} \left[\left(\frac{\text{Sin } \theta}{2} \right) \left(\frac{\text{Sin } \phi}{2} \right) \right]} \tag{5}$$

where θ = horizontal angle
 ϕ = vertical angle

Circular Dispersion

$$Q = \frac{2}{1 - \text{Cos } \frac{\theta}{2}} \tag{6}$$

If we use a hypothetical speaker with a dispersion of 40° × 100°, our Q would be 11.85, therefore our SPL, under the same conditions as the previous sphere, would be 118.2 dB SPL for a gain of 10.73 dB.

If the same driver was mounted in a speaker with a 100° circular dispersion, the Q would be 5.6, therefore, the gain over the sphere would only be 7.48 dB. This means that this speaker would require 2.11 more power than the same driver on the speaker with a 40° × 100° dispersion.

3—Electrical Power Required formula is:

$$\frac{\text{level required at 4' - speaker sensitivity}}{10} \tag{7}$$

Program EPR = 10

$$\frac{110 \text{ dB} - 99 \text{ dB}}{10}$$

Or in our case, EPR = 10 log = 12.6 Watts

4—The total amplifier power output per speaker is equivalent to the program power plus the crest factor, and it is calculated by the following formula:

$$\text{Total Amp power/spkr.} = \text{EPR program} \left(\frac{\text{crest factor}}{10} \right) \tag{8}$$

or Total Amp power/spkr. = EPR (10)

This means in our example, we would require

$$12.6 \text{ Watts} (10) = 126 \text{ Watts}$$

If you're surprised to learn that tubes solve some amplifier problems best, you have something to learn about amplifiers.

And about LUX.

It may seem courageously retrogressive for a company to introduce a *tube* amplifier—even a highly advanced type—to the semiconductor audio world of 1976. Especially for a company only recently established in the U.S. market with a comprehensive line of solid-state amplifiers and tuners. But for LUX, it is simply consistent with our philosophy: whatever path may lead to improvement in the accuracy of music reproduction will be explored by our audiophile/engineers. Whether it leads to transistors or tubes.

Certainly, transistors are not about to be obsoleted by tubes. However, there are some amplifier problems that tubes still handle better than transistors. Overloading is one such problem.

When a solid-state amplifier is driven beyond its rated power, it clips abruptly. Engineers call it "hard" clipping. The term is apt, as the sound from the spurious high-order odd harmonics is raspy and irritating. Further, if the overall circuitry is not stable, and the protective circuits not very well-designed, the distortion is extended in time beyond the moment of overload. Drive a tube amplifier beyond its rated power and it too clips the waveform, but gently and smoothly. This "soft" clipping introduces much smaller amounts of odd harmonics. The distortion is far less irritating, hence less noticeable.

Notch (or crossover) distortion, present in many transistor amplifiers, is another source of spurious high-order odd harmonics. It occurs when the transistor output circuits are not able to follow the musical waveform accurately at the points where it changes from positive to negative and back again. Since notch distortion, unlike clipping, is at a constant level regardless of the power the amplifier is delivering, the ratio of this distortion to signal is worse at lower power. The gritty quality heard from many transistor amplifiers, particularly when they are playing at low levels, is usually due to crossover distortion.

Of course, tubes also have *their* limitations. Especially

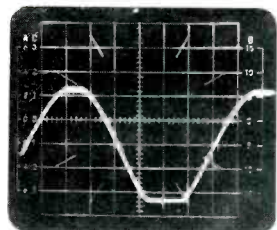
conventional tubes. The only tube previously capable of high-power amplification—the pentode—has inherently higher levels of distortion than the triode. Existing lower-distortion triode tubes cannot deliver sufficiently high power as a simple push-pull pair. But LUX, together with NEC engineers, has developed the first of a new breed of triode tube, the 8045G, which with other related technological advances, makes possible a high-power, low-distortion triode amplifier—the Luxman MB-3045. Among the differences in this new triode, the plate-electrode uses a special bonded metal with high heat-radiation characteristics. Also, the fin structure further aids heat dissipation.

LUX also developed a low-distortion high-voltage driver tube, the 6240G, capable of delivering over 200 volts of audio signal to the output triodes. Also, a new output transformer (LUX's long-time special area of expertise) has been designed to take optimal advantage of the triode configuration feeding it. The quadrafilar winding and core technology of this transformer represents another breakthrough. Overall, from input to output, the use of advanced design direct-coupled and self-balancing differential amplifier stages ensures stability and minimum phase shift.

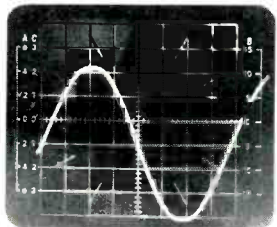
The MB-3045 produces a minimum of 50 watts continuous power into 4, 8, or 16 ohms, at any frequency from 20 to 20,000 Hz, with total harmonic distortion no more than 0.3%. As the MB-3045 is monophonic, a pair of them connected to a stereophonic preamplifier will not be subject to stereo power-supply interaction.

Now, we don't expect the MB-3045 to become the world's best-selling amplifier, any more than our highest-power solid state power amplifier, the M-6000 priced at nearly \$3000.

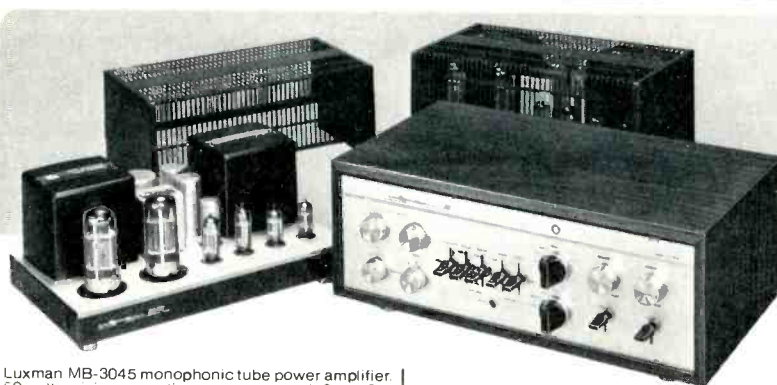
You'll find both at our carefully selected LUX dealers who will be pleased to demonstrate them for you. And any of the other dozen or so LUX models. It's why they're LUX dealers in the first place.



When a typical transistorized amplifier tries to deliver more power than it can, the top and bottom edges of the waveform clip sharply and abruptly and not always symmetrically. Result: high-order harmonic distortion, raspy and irritating.



When a tube amplifier, such as the Luxman MB-3045, is driven into overload, the clipping is softer, with more rounded edges to the waveform. The resulting distortion is much less audibly bothersome.



Luxman MB-3045 monophonic tube power amplifier. 50 watts minimum continuous power into 4, 8, or 16 ohms, 20-20 kHz, total harmonic distortion no more than 0.3%. Frequency response: 10 to 40 kHz, ± 1 dB. Signal to noise ratio: 95 dB. Variable sensitivity, control for matching gain to any preamplifier. \$445.00 each.
Luxman CL-35 III stereo tube preamplifier. Total harmonic distortion: 0.06% at 2.0 V, 20-20 kHz, all

output signals. Frequency response: 2-80 kHz, ± 0.5 dB. RIAA equalization: ± 0.3 dB. Features include: tape monitoring and dubbing, 6 selectable turnover frequencies, twin high and low noise filters, switchable phono-input impedance (30, 50, 100 kohms), variable input sensitivities. \$745.00

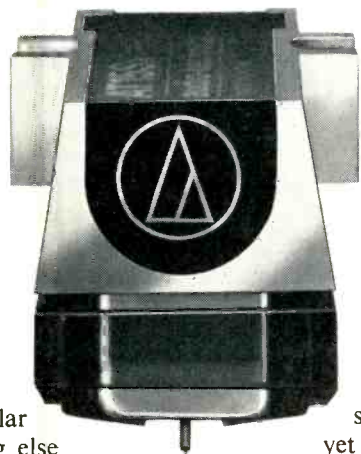
LUX Audio of America, Ltd.

200 Aerial Way, Syosset, New York 11791
 In Canada: AMX Sound Corp. Ltd., British Columbia, Genetric Ltd., Quebec

AmericanRadioHistory.Com

The phono cartridge that doesn't compromise any modern record.

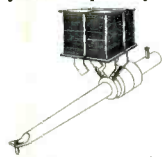
AT15Sa



32 Choosing an AT15Sa can add more listening pleasure per dollar than almost anything else in your hi-fi system. First, because it is one of our UNIVERSAL phono cartridges. Ideally suited for every record of today: mono, stereo, matrix or discrete 4-channel. And look at what you get.

Uniform response from 5 to 45,000 Hz. Proof of audible performance is on an individually-run curve, packed with every cartridge.

Stereo separation is outstanding. Not only at 1 kHz (where everyone is pretty good) but also at 10 kHz and above (where others fail). It's a result of our exclusive Dual Magnet* design that uses an individual low-mass magnet for each side of the record groove. Logical, simple and very effective.



Now, add up the benefits of a genuine Shibata stylus. It's truly the stylus of the future, and a major improvement over any elliptical stylus. The AT15Sa can track the highest recorded frequencies with ease, works in

*TM. U.S. Patent Nos. 3,720,796 and 3,761,647.

any good tone arm or player at reasonable settings (1-2 grams), yet sharply reduces record wear. Even compared to ellipticals tracking at a fraction of a gram. Your records will last longer, sound better.



Stress analysis photos show concentrated high pressure with elliptical stylus (left), reduced pressure, less groove distortion with Shibata stylus (right).

The AT15Sa even helps improve the sound of old, worn records. Because the Shibata stylus uses parts of the groove wall probably untouched by other elliptical or spherical styli. And the AT15Sa Shibata stylus is mounted on a thin-wall tapered tube, using a nude square-shank mounting. The result is less mass and greater precision than with common round-shank styli. It all adds up to lower distortion and smoother response. Differences you can hear on every record you play.


Don't choose a cartridge by name or price alone. Listen. With all kinds of records. Then choose. The AT15Sa UNIVERSAL Audio-Technica cartridge. Anything less is a compromise.

- away from the front of the audience.
- 5—Aim speakers at the audience.
- 6—Stack and splay speakers when using more than one speaker for coverage from one point.
- 7—Use speakers with smooth frequency response 250 Hz to 8 kHz.
- 8—Use 70 V speaker lines when speakers are more than 100 ft. from amplifier or more than two speakers are used.
- 9—Have battery-powered capabilities for amps.
- 10—Have at least two microphone inputs and one auxiliary input.
- 11—Use balanced low-Z microphones.
- 12—Use cardioid microphones for increased gain and improved S/N.
- 13—Place microphones between 25 and 50 feet from speakers. This gives adequate gain without time delay.
- 14—Have adequate coverage to insure no dead spots.

Don't

- 1—Don't put speakers on ground. Sound cannot go through or around people and objects.
- 2—Don't aim speakers in the air as this causes sound to go into unwanted areas.
- 3—Don't string speakers out more than 40 feet apart as this causes echo.
- 4—Don't boost bass control on the amplifier when speaker response is limited to 250 Hz. This will increase distortion and can destroy speakers.
- 5—Don't allow total speaker impedance to be lower than amplifier load impedance.
- 6—Don't connect speakers in series—parallel, as in temporary systems; this becomes confusing and often requires complicated wiring.
- 7—Don't allow people to plug cheap Hi-Z unbalanced microphones into a system as it will cause noise, oscillation, and poor quality.
- 8—Don't run speaker wires and microphone lines together as this will cause oscillation.
- 9—Don't run wires on the ground where people can trip on them, causing personal injury or defeating the PA system.

By following the above recommendations and using logic and common sense, outdoor "picnic" sound systems can be made to be a positive force in any outdoor function, rather than a "necessary evil."

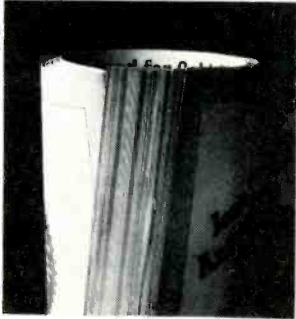
Handy references are *Sound Systems Engineering* by Don and Carolyn Davis and *Altec's Tech. Topics* 221, 212A, and 218. 

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AUDIO • AUGUST, 1976

ONCE AGAIN, THE EPI 100 HAS RECEIVED TOP RATINGS FROM THIS PRESTIGIOUS PUBLICATION.



In its February issue, the leading independent consumer testing magazine rated the EPI 100 the best speaker for the price among medium-priced speakers.

That's the good news.

The bad news is, because of its policy of strictly enforcing the copyright laws, we

can't name the magazine or quote it directly.

But we can tell you this: This is the third time running the EPI 100 has been so rated by the publication. And no wonder.

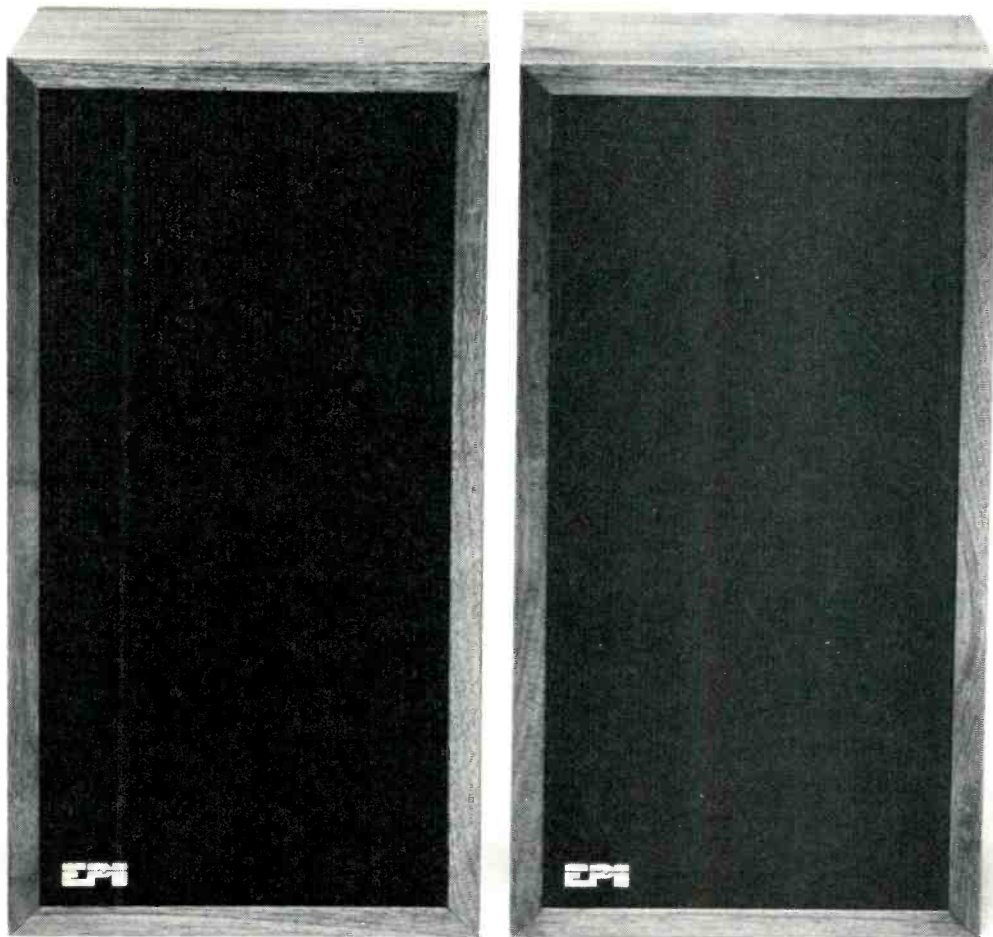
The EPI 100 offers EPI's celebrated Linear Sound: a pure, uncolored, natural sound from top to bottom. With no artificial boosting of the bass to impress the innocent. And all the nuances at the treble end that, on most speakers, just fade away.

The Model 100 doesn't just deliver the Linear Sound of EPI straight ahead, either. In fact, up to 15,000 Hz, the speaker's off-axis dispersion is down an average of only 3 db.

With its excellent dispersion and EPI's Linear Sound, we'd say the EPI 100 is clearly the finest speaker you can get for the money.

But don't take our word for it.

Take ██████████'s.

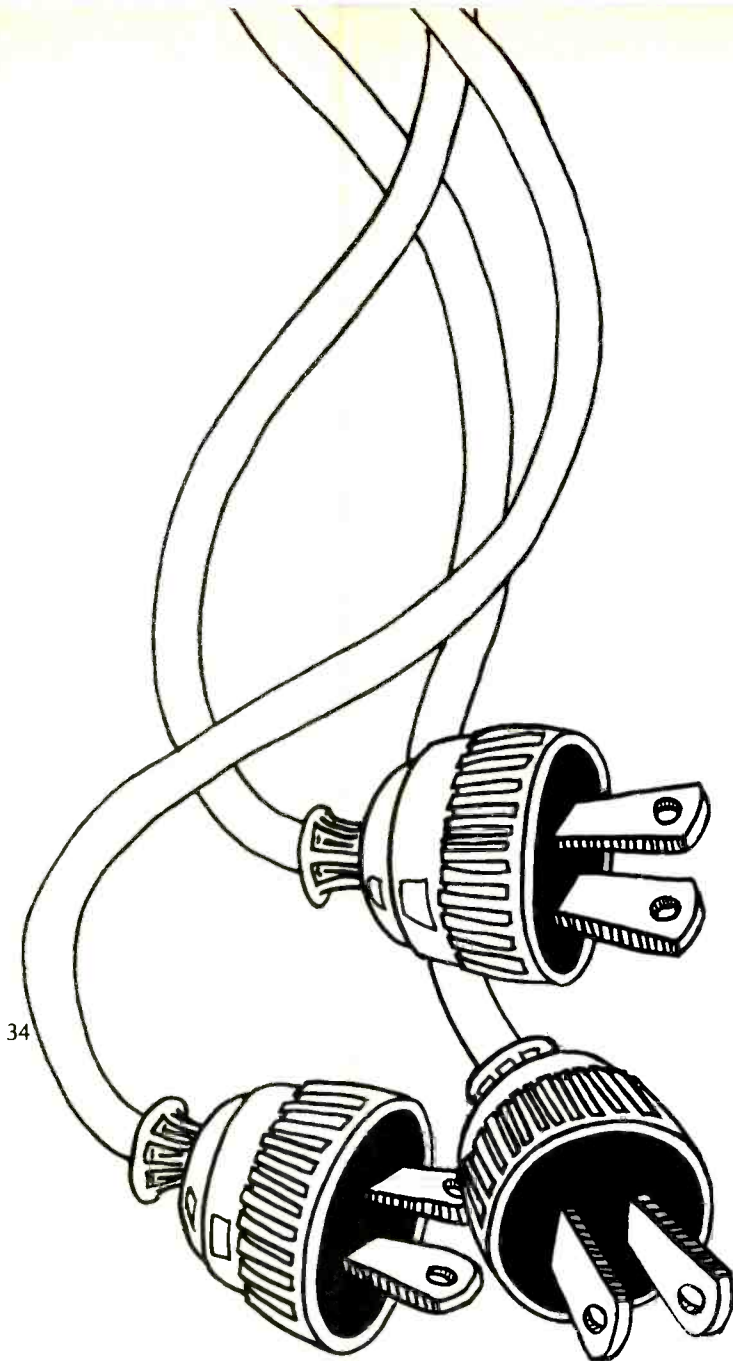


The Model 100 is available in a hand-rubbed walnut veneer or a vinyl finish (Model 100v).

THE LINEAR SOUND OF EPI

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SWITCHED-ON BASS

W. J. J. Hoge*

Recent studies have shown that most music has little program content below 40 Hz. The open E string of a bass (acoustic or electric) produces a note with a fundamental of 41.2 Hz, the low A on a piano has a fundamental of 27.5 Hz, and an organ with a 32-ft. pipe produces a low C with a 16.4 Hz component. However, the fundamentals of the notes produced by all of these instruments are very low in amplitude compared to the harmonics. Tests have shown that a loudspeaker with a 40 Hz cut off is adequate for reproduction of almost all music.¹ But there are exceptions to these general rules.

For example, it is now common practice to record an electric bass by plugging it directly into the recording console via a matching transformer. This avoids the deficient bass of most open-backed guitar speakers and provides a signal much richer in the fundamental, but the bass still only goes down to 41.2 Hz. To go farther down the spectrum, we must switch from instruments with acoustical signal generators to ones with electrical signal sources.

Dr. Moog's Synthesizer contains a set of electronic function generators and can produce low bass notes with very strong fundamentals. It is very easy to produce a low distortion sine wave with a synthesizer, a 16.4 Hz note which is 99-44/100% fundamental, for instance. Over the past few years musicians have become proficient with synthesizers, and a sizeable catalog of good electronic music is available on phonograph records. Should an engineer design loudspeakers to handle these records? What does it cost to extend the frequency response down an octave from the 40 Hz cut off, required by most music, to 20 Hz for electronic music? Remember, there is no such thing as a free lunch.

Some Theory

Dr. R. H. Small² of the University of Sydney has "done the math" on this problem as related to direct-radiator loudspeakers and gives us the following equation which relates reference efficiency, (η_0), low frequency cut off (f_3), and total enclosure volume (V_B):

where k_η is a constant related to the type of system (vented, closed-box, or passive radiator) and response alignment (Butterworth, Chebbychev, etc.). If η_0 is expressed in per cent, f_3 in Hz, and V_B in litres, then the maximum possible value of k_η is 3.9×10^{-7} for a vented-box and 2.0×10^{-7} for a closed box.

$$\eta_0 = k_\eta f_3^3 V_B \quad (1)$$

Let us assume the case of a typical vented-box with k_η of 3.0×10^{-7} , V_B of 60 litres (2.1 ft³), and f_3 of 40 Hz. This gives an efficiency of about 1.2%. Now, let us lower f_3 to 20 Hz. If we keep the same alignment (hold k_η constant), then either the efficiency must drop to around 0.14% or the enclosure size must go up to 480 litres (17 ft³). This is expensive in terms of either amplifier horsepower or timber.

Small also points out an approximate relationship between distortion (D) and low frequency cut off.

$$D \approx \frac{1}{f_3^4} \quad (2)$$

Thus, all other things being equal, a system with a 20 Hz cut off will have 16 times the distortion of one with a 40 Hz cut off. The largest part of the distortion results from the intermodulation of the higher frequency components of the signal with the lower ones.³

We now begin to see why almost all commercially available systems cut off between 40 and 60 Hz. There is little of musical interest below 40 Hz and system distortion increases rapidly as the system low frequency cut off goes down.

But suppose, Gentle Reader, that you, like the author, still want to feel those 20 Hz signals from a synthesizer while retaining reasonable efficiency and tolerable distortion in your system. This can be done with the addition of a sub-woofer. A sub-woofer is a low bass loudspeaker, generally used in a bridged-center configuration, which handles material below the range of the normal system's woofer. It offers two advantages. One, quite obviously, is extended bass response and the other is reduced distortion in the main system. This reduction in distortion is caused by easing the low-frequency requirements on the main woofer. Let us apply

*CTS of Paducah, Inc., Paducah, KY 42001

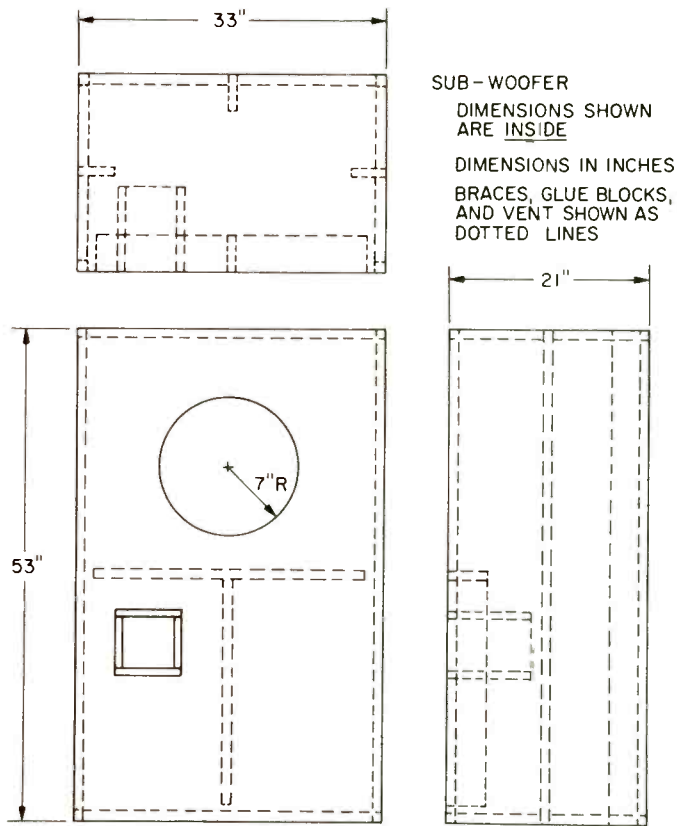


Fig. 1—Inside dimensions of loudspeaker box.

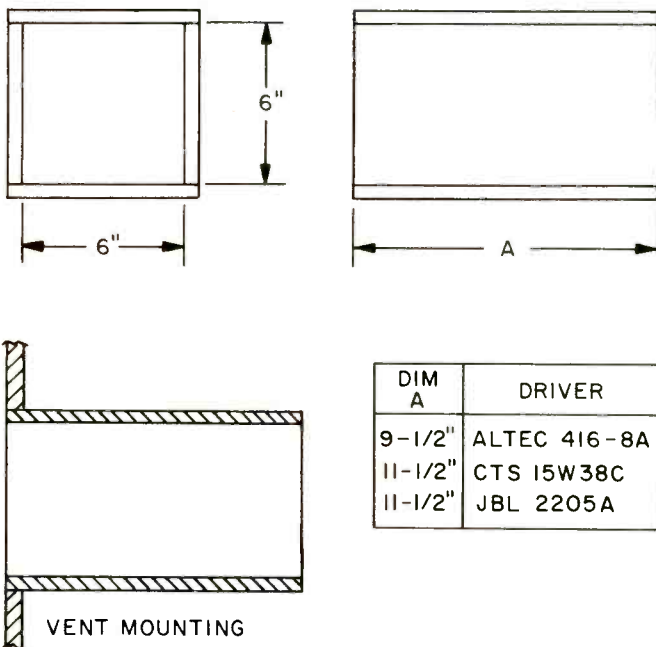


Fig. 2—Vent details for the loudspeaker box.

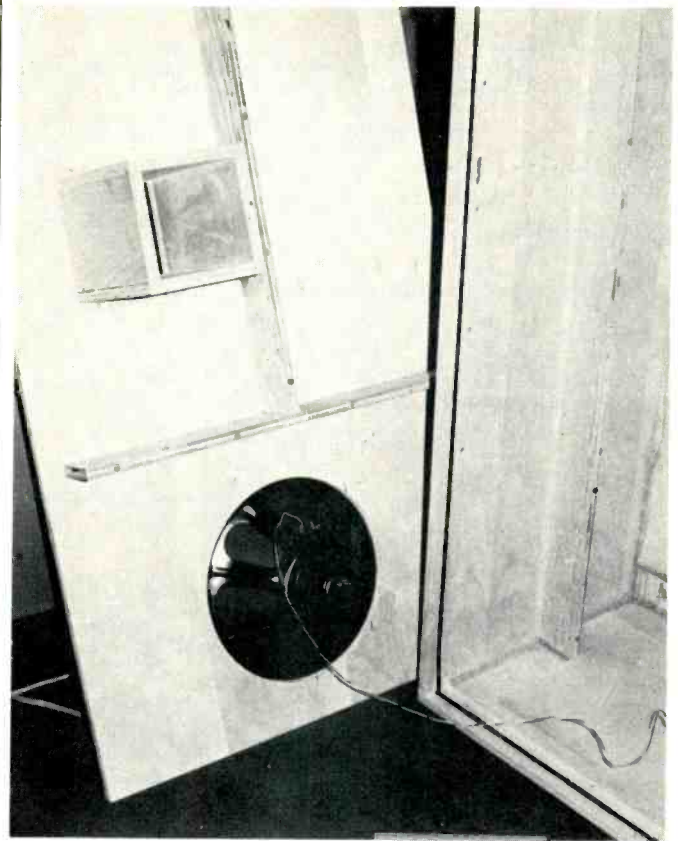


Fig. 3—Installation of the front panel gasket. Note the damping material, braces, and vent.

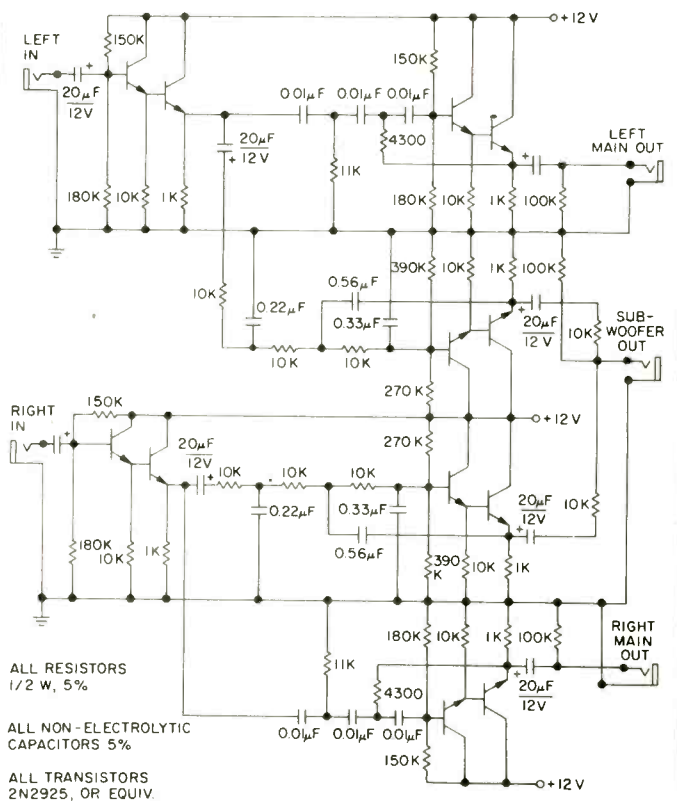
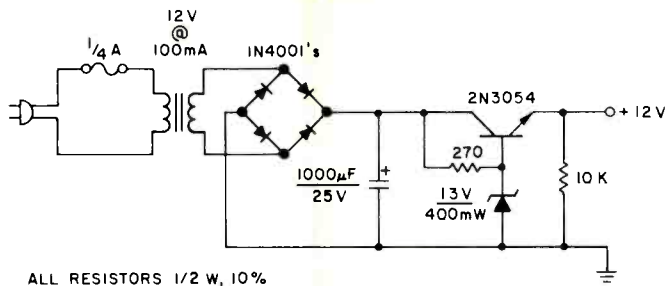


Fig. 4—Sub-woofer crossover schematic.



ALL RESISTORS 1/2 W, 10%

Fig. 5—Diagram of the power supply for crossover.

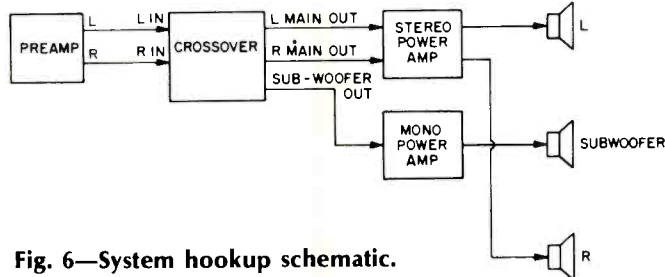


Fig. 6—System hookup schematic.

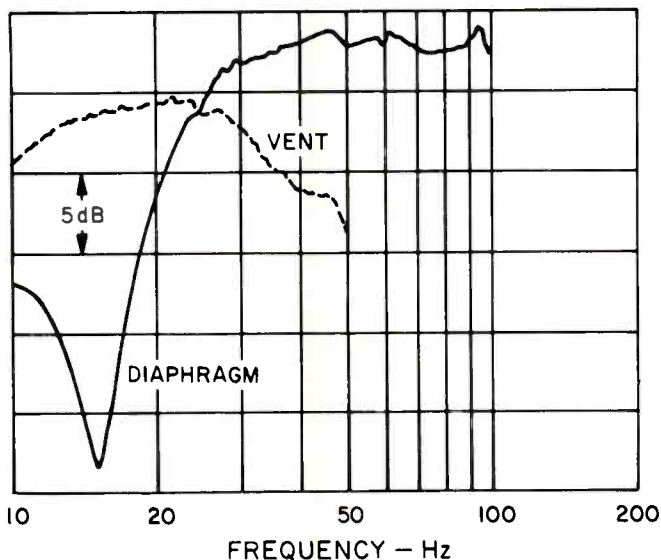
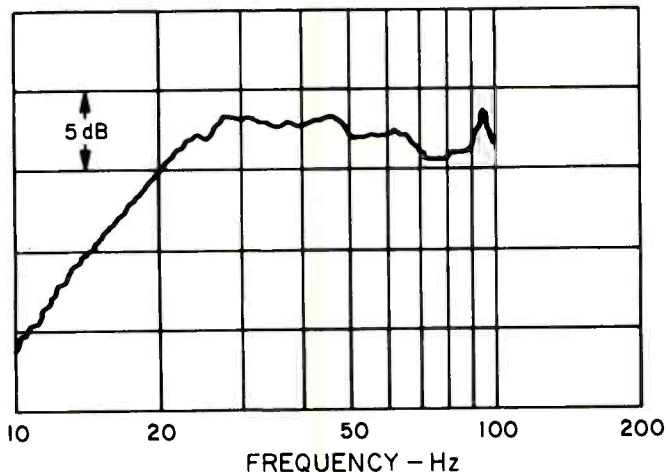


Fig. 7—Nearfield pressure in the 600-liter box.

Fig. 8—Nearfield pressure total of diaphragm and vent.



current loudspeaker synthesis procedures to the design of a sub-woofer and see what sort of system results.

Designing a Sub-Woofers

Before going any farther, we need to firmly establish our design objective. Let us try for a low frequency cut off of 20 Hz in a system with maximally-flat response. With this goal in mind, we must now choose the type of system and the alignment we will use. Since the low cut off requires a large box for reasonable efficiency, we should choose a type of system and alignment which will maximize efficiency per unit volume, and this means a vented-box. For an alignment, let us choose the 4th-order Butterworth (B4) which is maximally-flat. The Quasi-Butterworth 3rd-order (QB3) alignments are also flat, but require the driver resonance frequency to be lower than the system cut-off frequency. In the case of a 20 Hz cut off, this is an unreasonable requirement. Also, the QB3 alignments are more prone to problems caused by infrasonic signals, such as turntable rumble, than is the B4.

Next, we must fix the enclosure volume. 600 litres (21 ft³) is about the largest box that the author can squeeze into the living room of his small apartment; therefore, let V_B be 600 litres. This volume, when plugged into Eq. 1 along with the k_T of a B4 alignment and 20 Hz cut off, gives an efficiency of just over 1.0%.

Similarly, we must set the upper frequency limit for the sub-woofer. The 60-litre bookshelf systems (A & I Sound Aφ60s) in the author's apartment have a moderate 4th-order Chebbychev (C4) alignment with a 45-Hz cut off. Good engineering practice requires about an octave of overlap between the crossover frequency and the acoustical cut off of a driver

$$2 \times 45 \text{ Hz} = 90 \text{ Hz} \quad (3)$$

which can be rounded off to 100 Hz. This figure will give suitable overlap for systems with f_s 's in the 40- to 60-Hz region. The sub-woofer's response should extend an octave above the crossover. The formula below gives an approximate relationship between advertised basket diameter in inches (AD) and the upper acoustical cut off (f_{PR}) of a driver.

$$AD_{\text{max}} = 11,000 \div f_{PR} \quad (4)$$

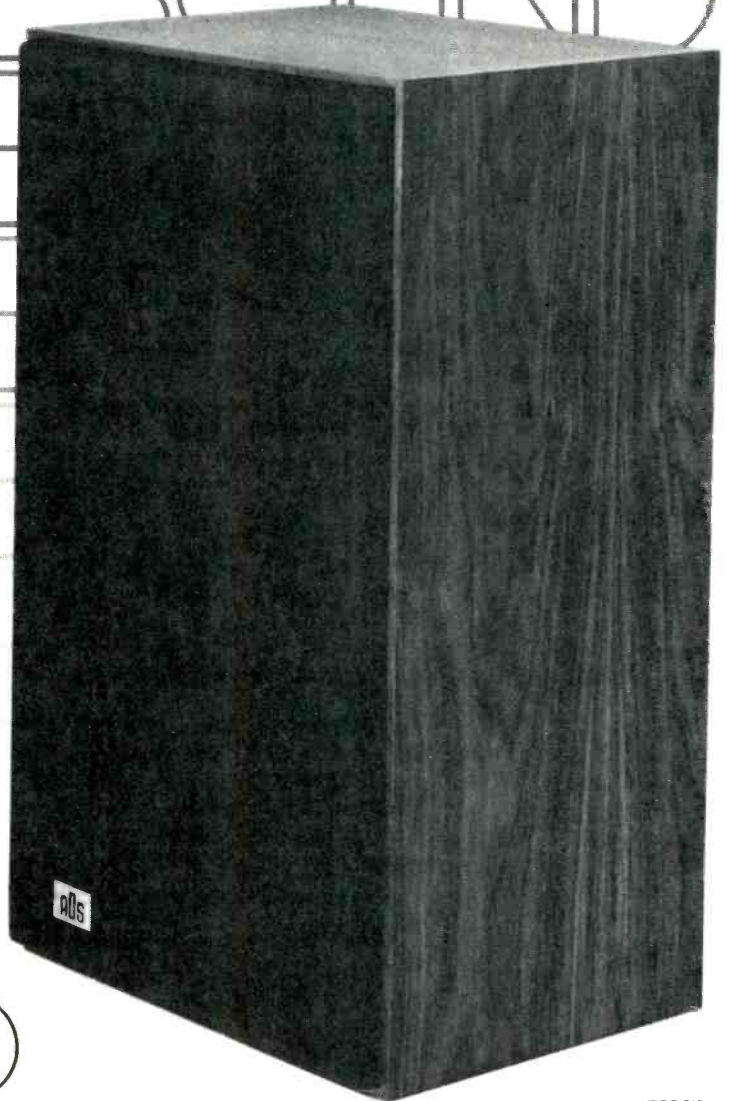
Plugging f_{PR} of 200 Hz into Eq. 4, we find that a driver with an advertised diameter of up to 55 in. would be useful. Since no one makes a 55-in. loudspeaker, we should try something smaller. We could use an 18-, 24-, or 30-in. unit. Since there are so few drivers from which to choose, let us limit ourselves to 15-in. units.

A. N. Thiele⁴ has given us a very useful table of potential vented-box system alignments. The table was reprinted in the August, 1975, issue of *Audio*.⁵ Referring to the table we find that for a 20-Hz B4 alignment in a 600-litre box, we want to use a driver with a resonance frequency (f_s) of 20 Hz, a total Q (Q_{TS}) of 0.38, and a compliance equivalent volume (V_{AS}) of 850 litres. The table gives the parameters of three potentially useful drivers, the Altec 416-BA, the CTS 51W38C, and the JBL 2205A. In the case of the Altec driver the Q_{TS} is too low, but it may be raised by adding a series resistor (R_C) which should have a power rating comparable to that of the driver. The V_{AS} of the JBL driver is too low to allow for a B4 alignment, but does allow a C4 alignment with less than 0.1 dB of amplitude ripple. Again, the Q_{TS} needs to be adjusted with a series resistor.

How to Build a Box

Each of the three possible systems uses the same basic enclosure with changes in the length of the vent and the addition of a series resistor being the only variations on the

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THE ADS 710

An opinion from an expert: The ADS 710 is a three-way bookshelf speaker of acoustic suspension design. It differs from other speakers of that genre in that it is very efficient, and is actually designed for shelf placement. The efficiency is achieved by the use of very strong magnetic assemblies in all of the drivers, substituting two 7" woofers for the more common single, larger unit. The end result is a speaker that has superb

frequency response without sacrificing the equally important transient characteristics. The sound of this speaker system is incredibly open and well defined, and the effect is that of listening to music, rather than to a loudspeaker.

- Martin Clifford.
Renowned Technical Editor

We couldn't have said it better.
ADS, Analog & Digital Systems
64 Industrial Way, Wilmington, MA 01887



Fig. 9—Microphone placement for Keele's method of measuring nearfield sound pressure.

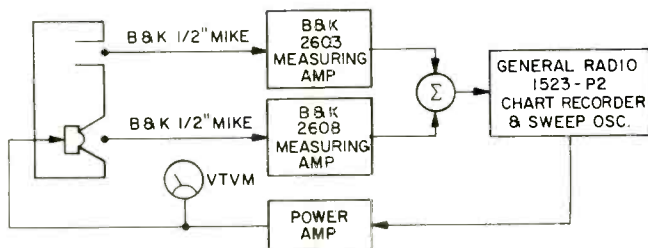


Fig. 10—Nearfield pressure test set.

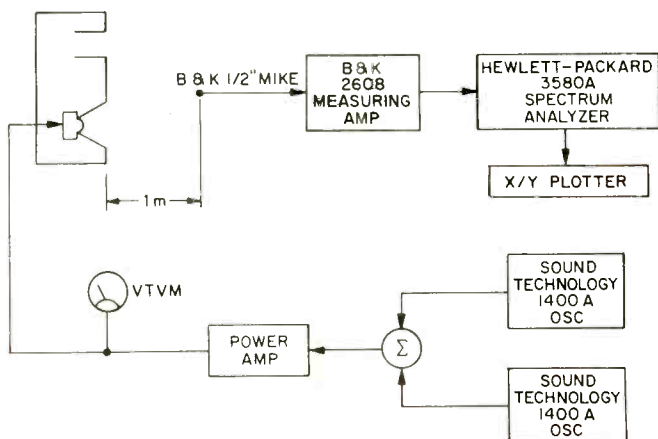


Fig. 11—Distortion test set.

them. The *inside* dimensions of the enclosure are 21 × 33 × 53 in. The walls should be made of 3/4-in. (or thicker) plywood. All the joints should be braced with glue blocks and secured with screws and glue. Note the use of the 1 × 4 in. braces. These steps are to insure that the enclosure is free of spurious rattles and resonances. The vent may be constructed of 1/2- or 3/4-in. plywood or particle board.

The enclosure should be lightly lined on three of the inside surfaces (e.g. top, back, and one side) with an absorptive material. The purpose of this material is to control standing waves inside of the box; it is *not* for the purpose of acoustic damping of the driver. Therefore, the material should be used sparingly and kept away from the driver and the vent. The principle "some is good, so more is better" does not apply in this case.

The first box standing wave will be in the stop band of the crossover filter. A small amount of damping material, together with the action of the crossover, will keep the standing waves from being excited by transient material such as music. In the prototype system, one layer of 1/2-in. thick polyurethane foam, similar to the type used for microphone windscreens, was found to be sufficient.

The front panel should be secured to the enclosure with plenty of screws. A gasketing material, such as Moretite, should be used to seal the joint between the front panel and the rest of the enclosure and to seal the joint between the driver and the front panel.

The Crossover

Unless a huge amount of floor space is available, it is best to use the sub-woofer as a bridged-center speaker. While it is possible to realize a passive network to go between the two power amplifiers, the two main speakers, and the sub-woofer, the inductors and capacitors would have to be very large and very expensive. The author was fortunate to have a spare mono power amplifier and, so, implemented an active crossover. The crossover consists of 3rd-Order Butterworth (18 dB/octave) networks. The reasons for selecting this filter type are beyond the scope of this text. (Author's Note: I wanted to use that line in a paper or article since I was a sophomore in college; I hope the Kindly Editor leaves it in the article. For a good discussion of crossovers, see Ashley & Kaminsky.)⁸ (Kindly Editor's Note: Sure, W.J.J., my pleasure, particularly since my personal favorite line, Baranek's Law, is used later in your paper.) One problem with many active crossovers is transient intermodulation distortion (TIM). The author's preamp and power amps are old TIM-free valve units. Previous attempts to build the filters using monolithic IC amps resulted in very bad "transistor sound." These filters were redesigned using transistor emitter-follower circuits which were TIM-free.^{6, 7} Standard 5% tolerances for the resistors and capacitors are tight enough for a crossover such as this one.

The Results

The prototype enclosure was assembled, and the CTS 15W38C was installed. The frequency response was measured using Keele's nearfield soundpressure method.⁹ The response is shown in Figs. 8 and 9. The response of the complete system (Fig. 9) is down 3 dB at 20 Hz which is as theory predicted. The equipment set up used in this measurement is shown in Figs. 10 and 11.

The system distortion was measured using Klipsch's method³ with the test set diagrammed in Fig. 11. Figure 12 is the plot from the spectrum analyzer. The loudspeaker was radiating two frequencies— f_1 of 27.5 Hz (A_0) and f_2 of 82.6 Hz (E_2)—each at a SPL of 95 dB re 20 μ Pa measured at 1 m. The

Avid makes the differences in speakers clear.

If you're a real stereo buff, you know that flat frequency response means flat, uncolored sound.

Like several other manufacturers, we too try to build the flattest, most linear frequency response we can into our speakers.

But we don't stop there. Because we know that great sound depends on more than just frequency response.

Transient response, for instance.

It's all in your head

To understand transient response, it's important to understand how you hear.

You see, you don't really hear with your ears. You hear with your brain.

For instance, it's the brain that helps you identify what you're listening to. The direction it's coming from. And that re-creates that illusion of "being there."

The thing is, every musical note is really a complex tone. A basic tone—the fundamental—plus subtle musical overtones—harmonics—that give every instrument a unique personality.



Not only that, musical notes are constantly starting and stopping. When they do, the number and intensity of the harmonics change.

This basic tone, together with all those changing harmonics, is called a transient. The brain takes all of them into account in interpreting any sound the ear receives.

On making things imperfectly clear

It's when a speaker can't react quickly or accurately enough to all those changing musical notes, all those transients, that distortion can occur.

And distortion means muddy-sounding music. With little definition or clarity.

A bad situation made worse when a speaker over-reacts to all those changing tones. The speaker actually adds tones of its own. And that's bad.

Most experts feel the best way to measure transient response is with tone bursts. Pure tones of various frequencies are rapidly switched on and off to simulate the transient nature of voice and instrument signals.

In Pattern A, the speaker hasn't reproduced accurately. It's completely overshoot the level of the input signal. And the result is a sizzling, hot sound. Totally colored.

In Pattern B, the speaker has taken too long to react. This "hangover" can cause considerable blurring. So what you hear is dull and lifeless.

Now look at Pattern C. The speaker here has reacted both quickly and accurately. And the result is exceptional clarity and definition. The kind that Avid builds into all of its speakers.

The proof is in the hearing

Now you know there's a lot more to a speaker than just flat frequency response. Like good transient response.

But even the best, most accurate

transient response in the world isn't the be-all and end-all of a superb speaker. There's more.

The point is, we're a company that is committed to one thing and one thing only. The design and construction of the clearest, best-sounding stereo speaker systems in their price range.

But you've got to hear for yourself. So go to your hi-fi store and listen to an Avid.

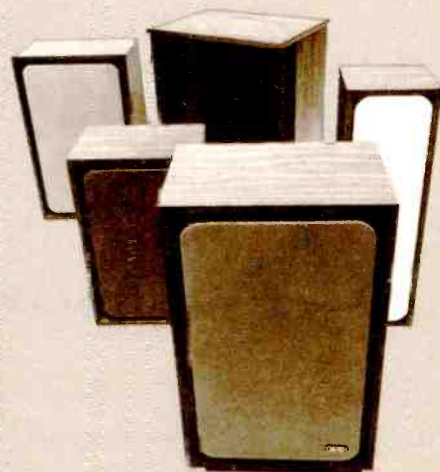
Then some other speaker in the same price category.

Then decide. We don't think you're going to have any trouble at all.

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ALIGNMENT TABLE

Driver	f_s (Hz)	Q_{TS}	V_{AS} (litres)	F_B (Hz)	l_p (in)	F_3 (Hz)	R_s (Ω)
Altec 416-8A	22	0.25	840	22	9.5	22	3.6
CTS 15W54C	20	0.39	840	20	11.5	20	—
JBL 2205A	22	0.22	620	19	11.5	20	4.7

f_s is resonance frequency of the driver, Q_{TS} is the total Q of the driver, V_{AS} is the compliance equivalent volume, F_B is the resonance frequency of the enclosure, l_p is the length of the port, F_3 is the low frequency cut off, and R_s is the value of the series resistor needed to trim the system.

total harmonic distortion was 2.6%, a tolerably low value. More important, the modulation distortion was only 1.1%, a very good value for a direct radiator system at such a high output power.

The system impedance was also measured. The magnitude of the minimum value of the impedance was 7.2 Ohm. An 8 Ohm rating would be justified for this system.

40 Conclusions

The measured response of the system is in reasonable agreement with what theory predicted. So, from that point of view, the project was successful.

Was it worth the trouble? The answer must be a qualified yes. On most program material it is not possible to hear any benefit from the sub-woofer. In this case it is not used, and the smaller main system handles everything.

In the case of electronic music the sub-woofer is, for the author, worthwhile. **Switched-On Bach** and other albums have a wealth of program material in the range of the sub-woofer. Of course, the author may be suffering from the effects of Beranek's Law:

"It has been remarked that if one selects his own components, builds his own enclosure, and is convinced that he has made a wise choice of design, then his own loudspeaker sounds better to him than does anyone else's loudspeaker. In this case, the frequency response of the loudspeaker

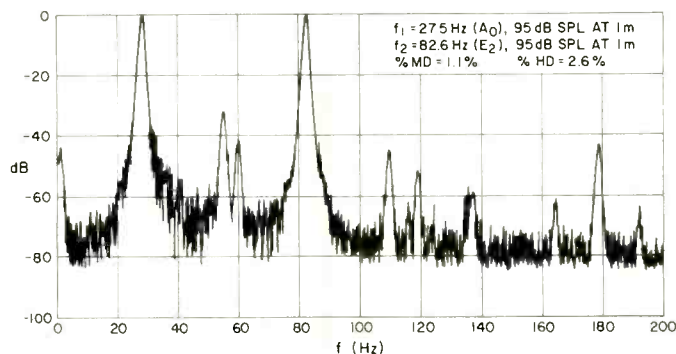


Fig. 12—Plot from the spectrum analyzer.

seems to play only a minor part in forming a person's opinion."—L. L. Beranek, *Acoustics*, McGraw-Hill, 1954, p. 208.

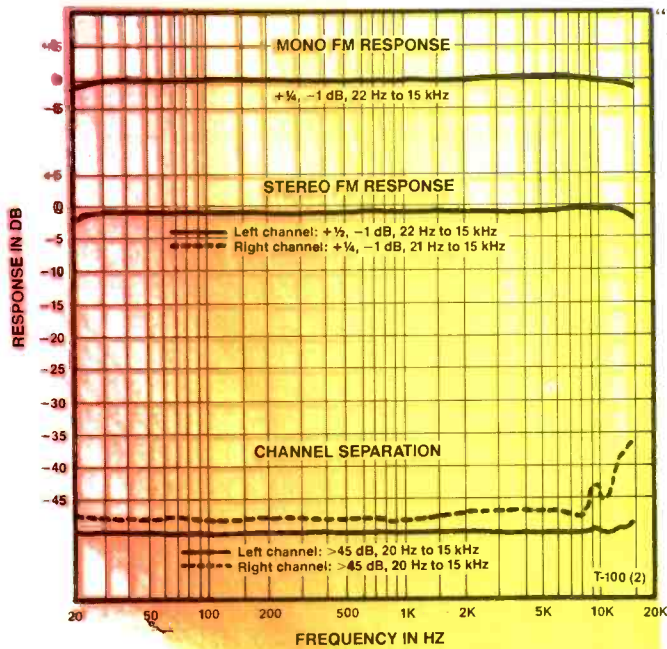
Acknowledgements

The author would like to thank Mr. Ken Bohleber of CTS of Paducah for his kind assistance in assembling the prototype system and tolerating a 600-litre box taking up space in the office/lab which he shares with the author.

Is 20 Hz low enough? How about 12 Hz? The author has designed a system using the same basic enclosure, with a different vent, and a CTS 18W54C. The system has an f_3 of 12 Hz. Thrill to the feel of 64-ft. organ pipes, thunder, earthquakes, and other natural disasters! For details, contact the author. A

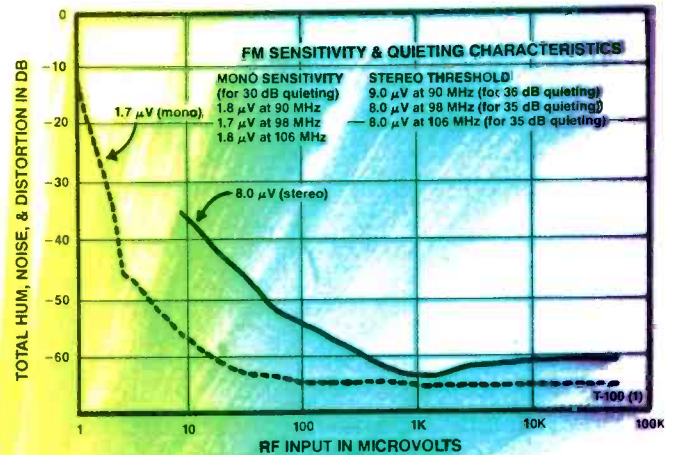
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Doppler Distortion in Loudspeakers

James Moir*

Of the many distortions produced by loudspeakers, the most controversial is probably Doppler distortion, some experts claiming that it does not exist, while others, notably Paul Klipsch and this writer, believe it to be the predominant residual distortion in cone-type systems.

Researchers may theorize for years over the subject of its existence and significance, but actual measurements of the distortion should short circuit much of the discussion, particularly when the argument against its importance is based on unsupported assumptions. This contribution includes such measurements on a variety of loudspeaker systems, many of the measured values having the great additional merit of being taken on the speakers while they are reproducing normal program material, speech and music. In minimizing the use of the standard sinusoidal test signal, it is believed that they set a new approach to the measurement of distortion. A little of the basic theory is perhaps a good start to the subject.

Frequency Intermodulation Distortion

Consider a loudspeaker reproducing two tones having frequencies f_1 and f_2 with a frequency ratio of 20 to one, then while the loudspeaker cone is moving towards the listener to reproduce one half cycle of the lower frequency, f_1 , it will simultaneously reproduce 10 complete cycles of the higher frequency, f_2 . While the cone is moving away from the listener on the reverse half cycle of the lower frequency, it will reproduce the second 10 cycles of the higher frequency. This is the classical Doppler situation, the pitch of the higher frequency as heard by the listener being increased as the source moves towards the listener, and decreased as the source moves away from the listener.

An observer listening to a signal frequency, f_2 , from a source moving towards him with a velocity, v , hears the

resultant note with a frequency, f'_2 , where,

$$f'_2 = f_2(c+v)/c$$

and c = velocity of sound in air. When the source is moving away from him he hears the note as having a frequency,

$$f''_2 = f_2(c-v)/c$$

The velocity of sound in air is around 1125 ft./s and the velocity of the speaker cone generally below 10 ft./s but dependent, of course, on the frequency and amplitude of the lower frequency. Thus, the maximum change in pitch (frequency) due to the Doppler effect is in the region below 1%. In FM transmission parlance, the Modulation Index (defined as Carrier Frequency Deviation \div Modulation Frequency) is very low.

When the moving source is a loudspeaker diaphragm executing a sinusoidal motion at the lower frequency while reproducing a high frequency tone, the pitch of the high frequency tone as heard by the listener will vary cyclically between the two limit frequencies quoted above at the frequency (f_1) of modulation, a simple example of frequency modulation. The mathematics of this are well understood, the known result being the appearance of two sidebands, symmetrically disposed about the carrier frequency, f_2 , at frequencies (f_2+f_1) and having amplitudes that are an indication of the extent of the Doppler distortion. It is necessary to differentiate between the value of the carrier frequency shift, Δf_2 measured in Hertz, and the frequency at which the sidebands due to this shift appear. The carrier shift is an indication of the extent of the Doppler distortion, and it is at its acceptable limit when it is only 20 to 30 Hz. The sidebands are always spaced from the carrier at the frequency of the low frequency modulation, f_1 , irrespective of the amount of Doppler distortion, because the carrier frequency deviation is cyclic at this modulating frequency. Measurements of the Doppler distortion are

made rather difficult because there is a second form of distortion that produces sidebands at exactly the same frequency as the Doppler mechanism.

Amplitude Intermodulation Distortion

These similar distortions appear when the same two-frequency test signal is applied to any device that has a non-linear input/output characteristic. If two sinusoidal voltages, $V_1 = V \sin(2\pi f_1 t)$ and $V_2 = \sin(2\pi f_2 t)$, are simultaneously applied to a device having a transfer characteristic represented by the power series,

$$V_0 = a_1 V + a_2 V^2 + a_3 V^3 + a_4 V^4 \quad (3)$$

the output will include in addition to the harmonics of the two test tones, f_1 and f_2 , two sidebands having frequencies of (f_2+f_1) and (f_2-f_1) with amplitudes in proportion to the coefficients a_2 and a_4 etc., in Equation 3. It will be seen that the frequencies of these two sidebands are identical to those produced by Doppler frequency intermodulation but the amplitude of the two sidebands is determined by an entirely different factor, the degree of amplitude non-linearity in the device. The extent of this non-linearity is indicated by the value of the coefficients a_2 and a_4 in the power series of Equation 3. The sideband frequencies produced by this amplitude dependent intermodulation are subsequently referred to as the A.I.M. sidebands. These A.I.M. sidebands are produced in loudspeakers by non-linearities in the suspension, non-uniform distribution of the magnetic field in the gap, and at higher frequencies by non-linearities in the cone material and in the magnetic system.

The distortion spectrum that results from applying two separate test frequencies is in the simplest example like that shown in Fig. 1. The two sidebands, $f_2 \pm f_1$, have amplitudes that are

*James Moir & Assoc., Chipperfield, Herts. WD4 9JJ, England.

the sum of the Doppler and amplitude modulation components, whereas the $f_2 \pm 2f_1$ are almost invariably due to amplitude intermodulation alone. The remaining two distortion components are the first two harmonics of the two test frequencies f_1 and f_2 .

It should be remembered that the presence of the amplitude dependent sidebands implies the simultaneous presence of the ordinary harmonic distortion components having frequencies of $2f_1, 3f_1, 2f_2, 3f_2$, etc. These have no equivalent in the frequency intermodulation case, so for equal amounts of distortion power in the Doppler and A.I.M. sidebands, the total distortion power due to the amplitude dependent distortions, the harmonics and amplitude intermodulation components, will usually be much greater than the total distortion power in the Doppler sidebands. The first order intermodulation sidebands having frequencies of $f_2 \pm f_1$, due either to Doppler or amplitude intermodulation, are seen to form only a small part of the total distortion power, but their effect in degrading the quality of the sound is not indicated by merely comparing the total power in the amplitude distortion components to the power in the Doppler distortion components. Critics have sometimes based their estimation of the importance of Doppler distortion on a comparison of the respective powers in the distortion products and on this basis come to the conclusion that Doppler distortion is not significant, but this cannot be justified.

It has generally been considered that the amplitude dependent distortions were the prime cause of much of the residual distortion in loudspeakers. Perhaps it should be remembered that it has never been conclusively demonstrated that the addition of the lower order harmonics alone results in any significant loss in sound quality. Thus, violins of unquestionable tonal quality differ markedly in their harmonic structure. The quality deterioration that is evident when harmonic distortion is present in an amplifier or loudspeaker is more reasonably assumed to be due to the sidebands components ($f_2 \pm f_1$), ($f_2 \pm 2f_1$), etc., that inevitably accompany harmonic distortion in a loudspeaker, but do not accompany the harmonics in musical instruments.

Measurement Technique

Separate determination of the amplitudes of the amplitude inter-

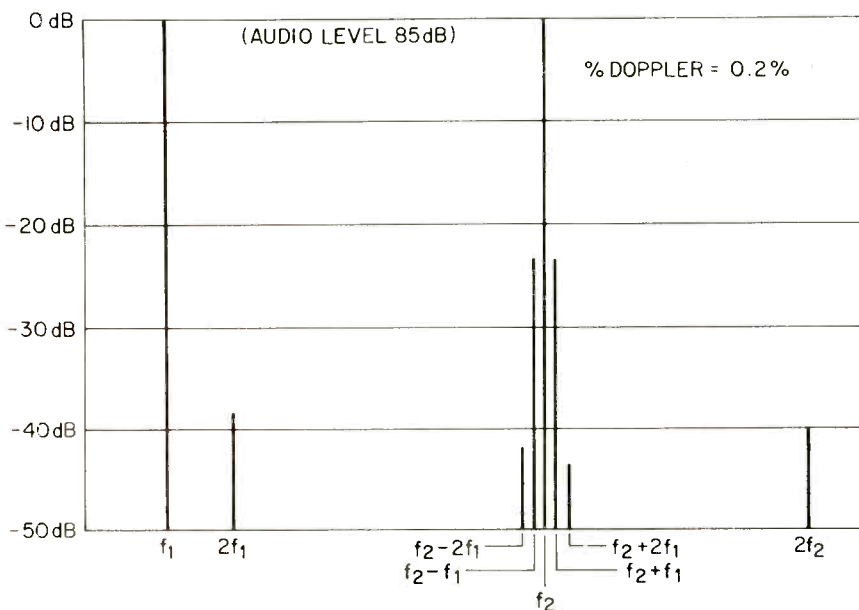


Fig. 1—Spectrum of Doppler distortion on a 7-in. loudspeaker.

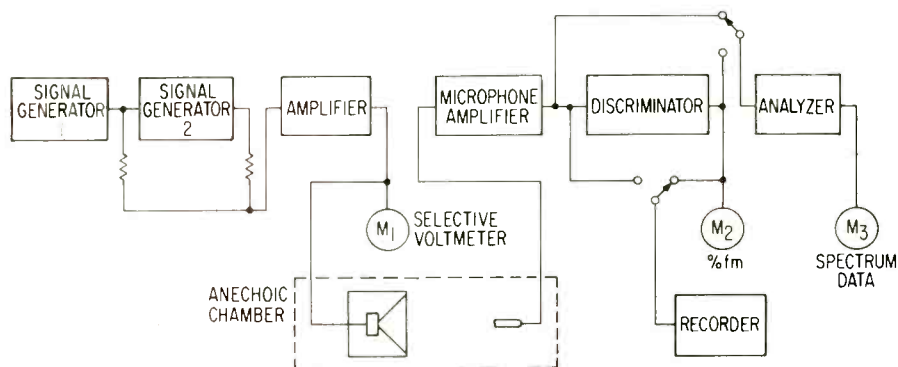


Fig. 2—Block diagram of the two-tone test equipment.

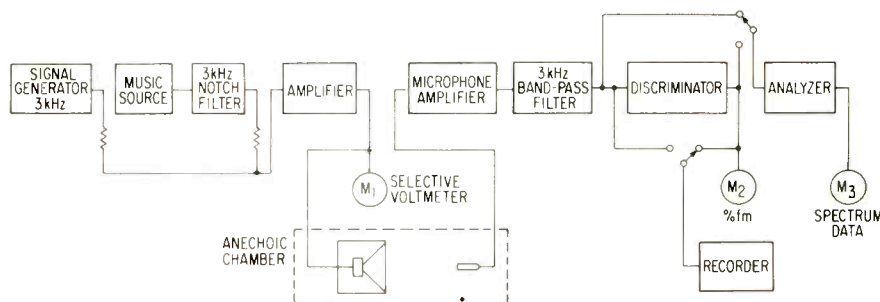


Fig. 3—Block diagram of the modified "on program" test equipment.

modulation and Doppler sidebands has evidently proved difficult if judged by the complexity of some of the techniques that have been used. The technique to be described provides a simple method that not only separates the two sets of sidebands from each other even though they have the same frequencies, but allows the Doppler sidebands produced by the loudspeaker to be separated from the music being reproduced by the same loudspeaker.

Our technique is to insert an amplitude limiter and FM discriminator de-

signed for a carrier frequency of 3 kHz into the measuring system. This particular carrier frequency was chosen as it allows the data obtained to be compared with that obtained by other investigators when assessing the subjective effect of wow and flutter, a very similar form of frequency intermodulation distortion.

The arrangement of the test equipment is shown in the block diagram of Fig. 2. Test signals are provided by two Bruel & Kjaer type 1014 signal generators, adequately decoupled and fed via a Quad type 303 50-watt amplifier

to the loudspeaker under test mounted in the open air. The output signal from the loudspeaker is picked up by a Bruel & Kjaer type 4131 microphone mounted on the axis of the speaker at a distance of 1 meter, amplified and then fed in parallel to the 3-kHz limiter and discriminator and to a Marconi type 2330 narrow-band analyzer. Meter M_1 checks the amplitude of the two separate input signal components f_1 and f_2 and the total amplitude of the combined signals, meter M_2 reads the FM distortion components only, while Meter M_3 indicates the amplitude of each of the individual components of the speaker output signal spectrum. The reading of M_2 is proportional to the frequency deviation of the carrier f_2 . This is related to the modulation index, M , by the simple relation,

$$M = (\Delta f_2 \times f_2) / f_1$$

With the narrow band analyzer switched to the output of the microphone amplifier, it will read the rms sum of the amplitude intermodulation and frequency intermodulation components at that particular frequency. When switched to the output of the discriminator, it will read the amplitude of the FM component only. The amplitude of the AM component can be determined by subtracting the FM component from the total. In the first test to be described two sinusoidal tones were used for the investigation, a low frequency signal around 70 to 90 Hz with a high frequency signal of 3 kHz being employed.

Test Samples

Three speakers of different sizes were used for the preliminary investigation but the data is typical of many other speakers tested. The choice was biased towards demonstrating the effect of radiator size on the AM and Doppler distortions.

The first unit tested was a 12 in. (30.4 cm) cone speaker covering the full audio range mounted in a ported enclosure having a volume of 3,200 cu. in. The second was an enclosure of 1498 cu. in. using a single 7 in. (17.7 cm) diameter unit to cover the full range. The third was a 4 in. (10.1 cm) diameter unit in an enclosure of 400 cu. in.

All three systems were operated at an on-axis sound pressure level of 85 dB at the modulating frequency f_1 of 90 Hz. It is appreciated that this may be a little below the sound level at which the hi-fi enthusiast may operate his system but it enables the perform-

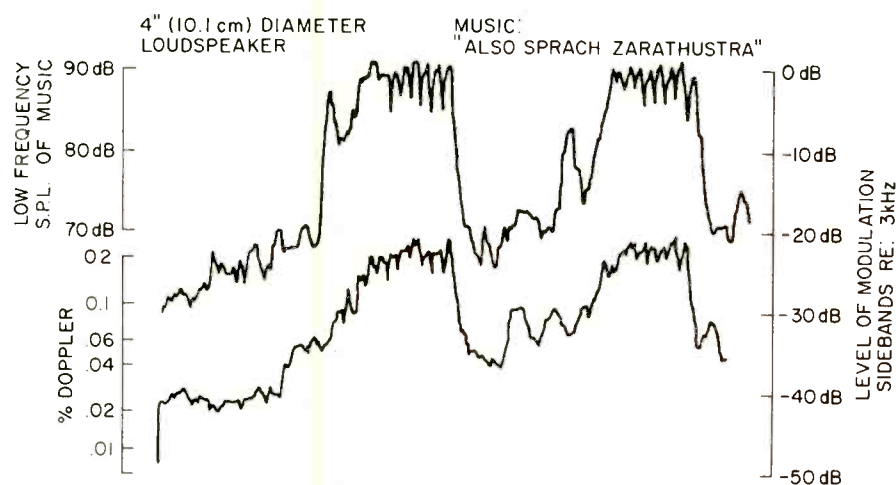
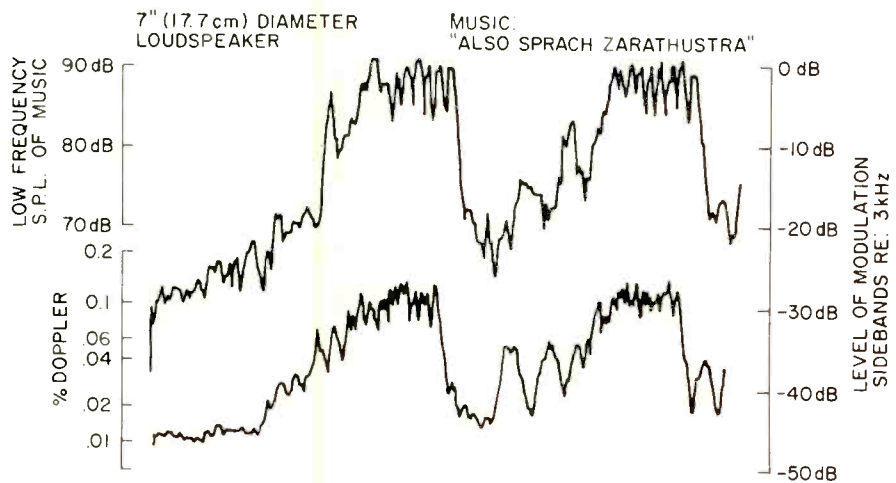


Fig. 4—Doppler distortion on two loudspeakers: 4A (top) with a 4-in. (10.1 cm) and, 4B (bottom) a 7-in. (17.7 cm) speaker.





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ance of the three systems to be compared at the same sound level without grossly overloading the smaller units. In all cases the level of the lower frequency, f_1 , was varied over a range sufficient to confirm the expected relation between sound pressure level and distortion.

Test Data

The 4-in. diameter unit happened to be the first to be measured, and the result was rather surprising for the calculated values of Doppler distortion agreed almost exactly with the values

measured by the analyzer, the sideband amplitudes being the same when the analyzer was connected either to the output of the microphone amplifier or to the output of the discriminator. This implies that *all* the ($f_2 \pm f_1$) sidebands were due to Doppler distortion and that the amplitude intermodulation contributed little to the total amplitude of the sidebands. Our initial surprise led to some very careful rechecking of the whole measuring system and of other speakers, and we gradually came round to the obvious conclusion that practically all

Table 1—Intermodulation Distortion in Typical Speaker Systems.

Cone diameter (in.)	Amplitude (dB)	Frequency (dB)
4	-40	-16
7	-41	-25
12	-43	-41

the intermodulation distortion in small units was due to Doppler.

Data on three systems is contained in Table 1 from which it will be seen that when using a speaker with a cone diameter of seven inches, the Doppler intermodulation distortions exceeded the amplitude intermodulation distortions at the same frequencies by 16 dB, confirming the theoretical prediction that when operated at the same acoustic power level small speakers produce more distortion than do large speakers. The oft repeated claim that a small cone performing a large excursion is just as good as a large cone executing a small excursion is seen to be an over-simplification of the situation. The acoustic signal "knows" whether it has been radiated by a small loudspeaker or a large loudspeaker. It should be emphasized that the use of "long throw" units with very flexible linear surrounds is no solution to the Doppler distortion problem, though their use does minimize the amplitude dependent intermodulation distortions.

It will also be seen that in typical units having cone diameters less than about 12 inches, the Doppler distortion sidebands greatly exceed the amplitude intermodulation sidebands. As the previous discussion shows that these Doppler distortion components have the same frequency as the distortion components due to amplitude intermodulation, it is apparent that in the typical units tested Doppler distortion is a more serious cause of sound quality degradation than is amplitude intermodulation, quite contradicting the generally held view.

However, the interesting aspect is the possibility of measuring the Doppler distortion while the loudspeaker is reproducing program material. Two-tone testing, using sine wave signals, produces accurate data that applies in the test conditions, but it requires a semi-arbitrary choice of the test tone frequencies and their relative amplitudes. Even with this infor-

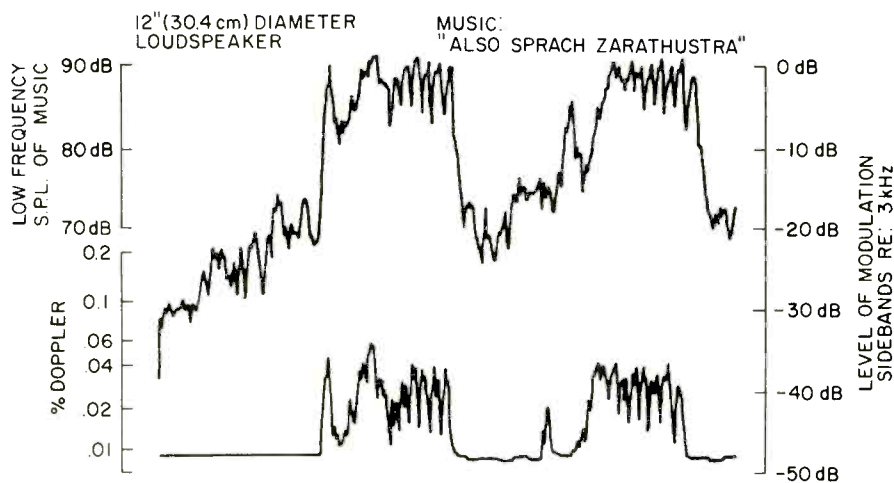
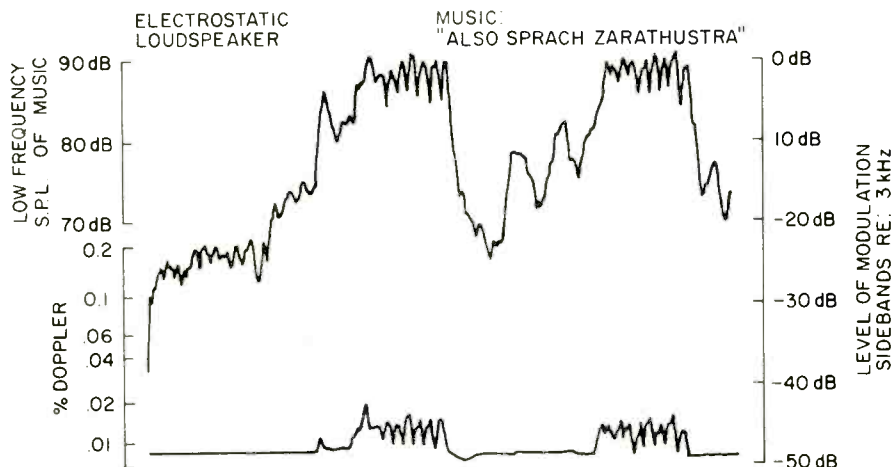


Fig. 5—Doppler distortion comparisons between 5A (top) a 12-in. loudspeaker and, 5B (bottom) an electrostatic speaker.



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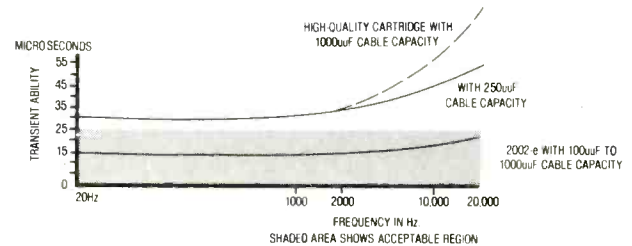
After all, transients are what music is made of: sudden start-and-stop bursts of sound at all frequencies. From the attack of a low organ note to the bite of a plucked string. Transient information is essential to differentiate the sound of one instrument from another, and in stereo, to localize instruments in space. That's why, *without good transient ability, no cartridge can reproduce music with really lifelike clarity.*

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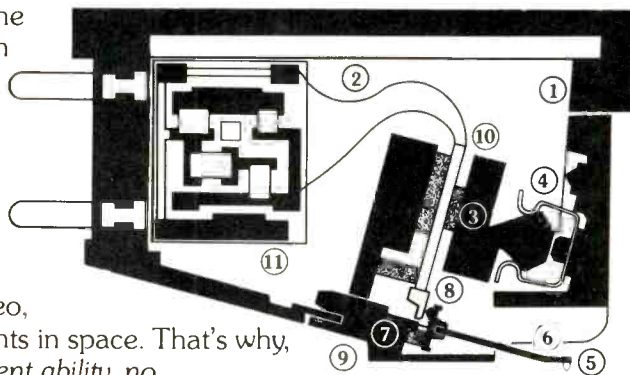
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mation, it is necessary to decide whether these conditions are relevant when reproducing music. It occurred to this writer that it should be possible to measure the extent of the Doppler distortion while the loudspeaker was actually reproducing music, the technique being as follows:

The block circuit diagram is shown in Fig. 3, a modified form of the current shown in Fig. 2. A flutter-free, 3-kHz test signal is inserted in the music program by inserting a notch filter tuned to 3 kHz into a suitable point in the output of the tape recorder to at-

tenuate the 3-kHz components of the music, and replacing these with a 3-kHz, flutter-free tone from a suitable signal generator. The amplitude of this test tone is held constant at some suitable value.

When the music is being reproduced, the cone excursions due to the low frequency components of the music Doppler modulate the 3-kHz test signal in just the same manner as they modulate any high frequency component of the music. The loudspeaker output signal derived from the microphone is then passed

through a band-pass filter that eliminates all the frequencies except those in a narrow band centered on 3 kHz and including the Doppler modulated 3-kHz test signal. This narrow band is then passed through the 3-kHz demodulator and the amplitude measured by a suitable meter and chart recorder.

To obtain simultaneous recordings of the program signal and the consequent distortion, the chart recorder was switched to the output of the microphone and a standard piece of music replayed from a professional 15 ips tape recorder. This produced the top trace on the charts, as shown. The chart and tape were then rewound and the music repeated with the chart recorder connected to the FM discriminator output. This produced the lower trace showing the variation in the Doppler distortion as the signal amplitude varied.

Figures 4, 5, and 6 illustrate some of the information obtained on several speaker systems including several very expensive enclosures. The curves of Figs. 4A and 5A illustrate the results obtained using 4-in. and 12-in. diameter units in suitable enclosures, and it will be seen that Doppler distortion in the smaller unit is about five times higher than in the 12-in. unit.

No self-respecting designer would rely today on a single unit to cover the whole audio band, and two, three, and four unit assemblies are the common solution to the problem of obtaining a wide overall frequency response. It is often claimed that this division of responsibilities is also a solution to the Doppler distortion problem, but the curves of Fig. 6 show that this is not necessarily true.

Figure 6B is an indication of the performance of an expensive three unit system with a sub-optimum choice of changeover frequencies and crossover network design. It will be seen that the performance is little better than that of a single 12-in. unit, at least in respect of Doppler distortion, the Doppler distortions being some 30 dB below the level of the 3-kHz test tone. That a multiple unit system can be a solution is indicated by the curves of Fig. 5B taken on a well-known, wide-range electrostatic speaker system. The Doppler distortions are seen to be about 45 dB below the test tone level, some 15 dB better than the expensive 3 unit system of Fig. 6B.

Significance of Doppler Distortion

That Doppler distortion does occur can hardly be disputed in view of these and similar results published by

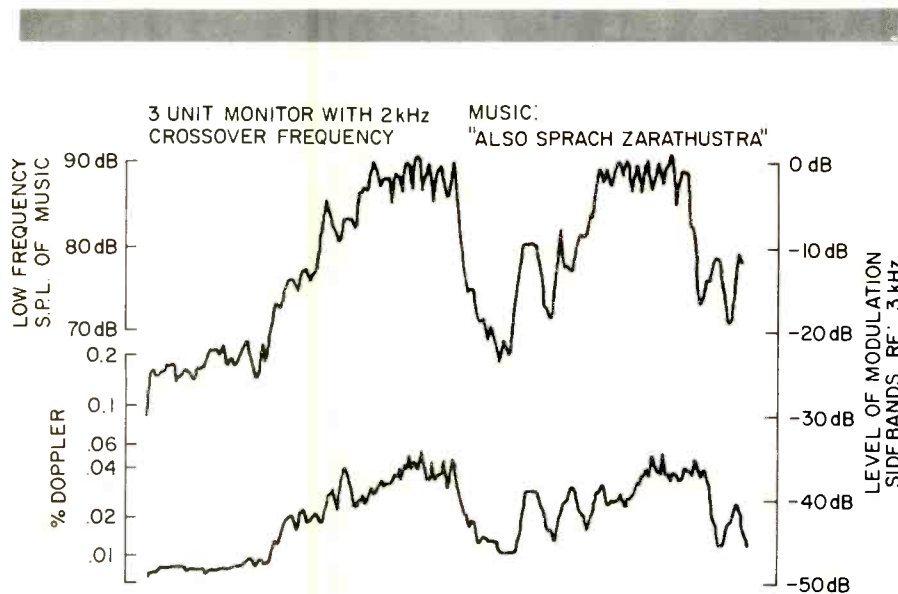
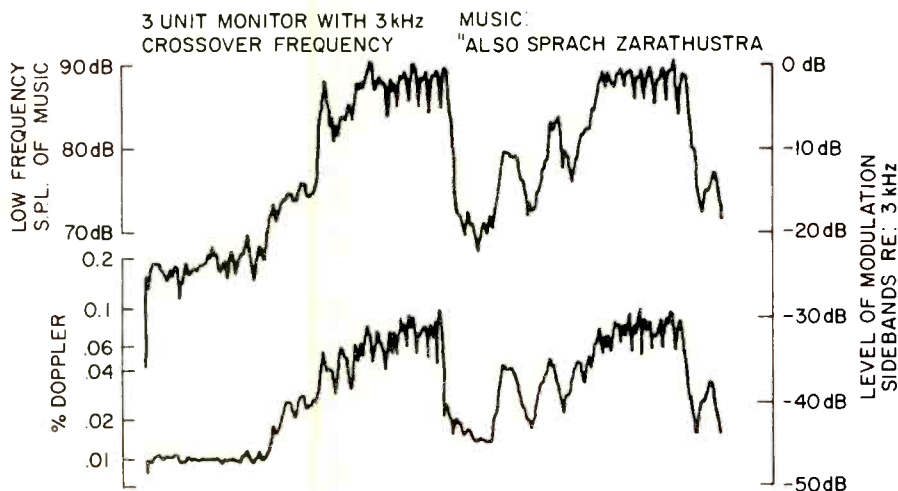


Fig. 6—Characteristics of Doppler distortion with three-unit speakers showing: 6A (top) a 2 kHz and, 6B (bottom) the 3 kHz crossover.



PART TWO: THE END OF THE DOUBLE STANDARD.

In the frequency range where you find most music, our least expensive speaker offers virtually the same flat frequency response and freedom from distortion as our most expensive speaker.

Until recently, you could consider the selection of speakers an act of faith.

Because of the lack of industry standards and the resulting confusion in the marketplace, the speaker buyer had to depend almost totally on personal taste and subjective evaluation.

But no longer.

At Yamaha, before we designed a new line of speakers that would equal the revolutionary standard of our electronic components, we first defined our goal:

High accuracy across the musical spectrum. One of the few objective criteria for rating speaker performance.

Then we proceeded to make all Yamaha speakers to a single revolutionary standard of accuracy:

A frequency response curve that varies by no more than ± 3 dB from 100 Hz to 15,000 Hz. With typically no more than 1% harmonic distortion.

But since the frequency range of all our speakers extends well below 60 Hz to beyond 15,000 Hz, why do we even bother mentioning this figure?

Because, with the exception of the very deepest rumblings of a pipe organ, all music is produced within this range. In fact, few if any commercially available stereo pressings have frequencies below 100 Hz and above 15,000 Hz.

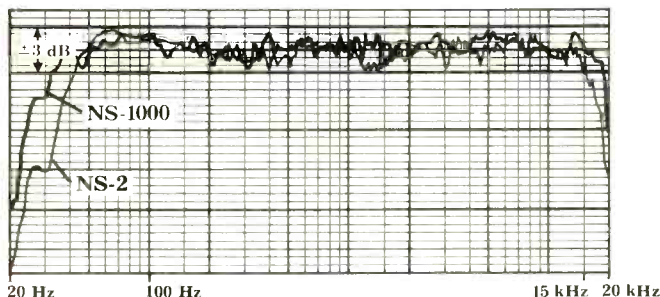
Yamaha's success in achieving a single standard of accuracy in all our speakers is confirmed in the chart above.

Unlike the frequency response curves of other speaker manufacturers which indicate unnatural booming in the bass, added sparkle in the treble, and extreme loudness level variations of as much as 10 dB, Yamaha's frequency response curves show a relatively straight line, which indicates uncolored, natural sound.

Yamaha's musical heritage.

Yet, in spite of Yamaha's objectivity in design, the perception of sound remains subjective.

That's why Yamaha speakers aren't designed to meet objective standards alone, but to meet a higher standard: the ears of the people who make Yamaha's world-famous musical instruments.



While many manufacturers offer accurate reproduction only in their top-end speakers, Yamaha brings you an extremely high degree of accuracy in all models throughout the line.

The above curves, comparing the NS-1000 with the NS-2, were recorded under the following conditions: 1. **Equipment used** - Bruell & Kjaer 8133 microphone, 1022 oscillator, 2113 spectrometer, and 2305 recorder. 2. **Input** - A "pink" noise source was used with an input level of 3 watts (significantly higher, more rigorous, and more closely corresponding to actual home listening levels than the commonly used industry standard of 1 watt). 3. **Measurement** - Each loudspeaker was placed in a "free field" (off the floor and no closer than 5 feet to any wall boundary in an average size listening room). A multiplicity of curves were taken at various points in the listening room and averaged, to produce the *total energy* curves pictured.

Since 1887, Yamaha has been making some of the finest musical instruments in the world. Pianos, organs, woodwinds, guitars, and brass.

With our musical instruments, we've defined the standard in the production of fine sound. And now, with our entire line of speakers and electronic components, we've utilized not only our studio engineers, but also our musical instrument designers to define the standard of music reproduction.

It's called Natural Sound. And it's totally unique to Yamaha.

Five different speakers, built to one standard.

Yamaha offers five different speaker models, ranging in price from \$1,350 a pair down to \$200 a pair.

At the top, the revolutionary beryllium dome NS-1000 Series, offering the ultimate in state-of-the-art performance. Following the NS-1000 are our

other three-way types: the NS-690, NS-670, and NS-3. Our least expensive, but still highly accurate, is the two-way NS-2.

Since each is built to the same high quality standard, you're probably wondering what those extra dollars are buying.

It's very simple.

To satisfy the most demanding audiophiles, those extra dollars buy extended response at the frequency extremes. Higher sound levels with equal or lower distortion. More power handling capacity. More tone controls to contour the tonal balance of the speakers with the characteristics of the room.

More specifically, on our model NS-670 and above, Yamaha offers die-cast speaker frame baskets to eliminate potential resonance. Luxurious wood enclosures (even rare ebony wood!). Tangential-edge

suspension for midrange and tweeter domes to provide smooth response. Acoustic equalizers on tweeters to flatten frequency response and enhance dispersion. Diagonally edge-wound voice coils for greater diaphragm control and increased transient response. Plus thick felt lining inside the cabinetry to isolate rear sound waves for distortion-free bass response.

But regardless of how much you pay, every Yamaha speaker is built to the same essential construction criteria and tonal accuracy.

Proven acoustic suspension design. Dome drivers for better high frequency dispersion. Carefully matched crossover networks. And heavily reinforced, extremely rigid enclosures.

The End of the Double Standard.

The single standard of performance found throughout the entire line of Yamaha speakers is a demonstration of product integrity that no other manufacturer can claim.

But in the final analysis, only your ears can be the judge.

That's why we invite you to visit your Yamaha audio dealer soon. His knowledgeable salesman and extensive demonstration facilities can save you time and trouble in selecting the speaker that's right for your budget. And right for your ears.



 **YAMAHA**

International Corp., P.O. Box 6600, Buena Park, Calif. 90620

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Klipsch, but it is more difficult to decide on the significance of the distortion when it occurs in a loudspeaker. It is clearly unreasonable to claim that it is less important than amplitude intermodulation distortion where the measurements show that the intermodulation sidebands produced by Doppler are of greater amplitude than the amplitude intermodulation sidebands at the same frequency that results from non-linearity in the loudspeaker.

We attempted a separate assessment with a small listening crew. The Doppler sidebands in the 3-kHz region were removed from a recording by suitable filters and tape recorded. Amplitude dependent sidebands in the same frequency band were similarly obtained by filtering the output of a slightly overloaded amplifier playing the same piece of music. The two sets of recorded side bands were then compared while being replayed at the same loudness level. Both ob-

servers were agreed that the Doppler sidebands were more annoying than an equal percentage of the amplitude intermodulation sidebands. That they should be *more annoying* than an equal percentage of amplitude intermodulation distortion is rather surprising and no explanation is offered, but the result is recorded for later consideration.

Some lower key confirmation was provided by a review of some earlier tests. Several months before the commencement of the investigation, three good loudspeaker systems had been subjectively compared and ranked by two observers. Some months later when the Doppler measuring equipment had been assembled, the three systems were objectively assessed. It was then found that the earlier subjective ranking in respect to "roughness" agreed exactly with the later objective ranking in respect of Doppler distortion. By that time both observers had considerable experience in recognizing Doppler distortion in a loudspeaker and they were agreed that the "roughness" commented on many months earlier was indeed due to Doppler.

Though we have not had an opportunity of objectively assessing the Doppler distortion content of a good horn-type loudspeaker, we believe from simple listening tests that their characteristic clarity is largely due to the absence of Doppler distortion. The same comment can be made about the performance of the wide-range electrostatic loudspeaker.

Bibliography

The subject of Doppler distortion in loudspeakers was first raised by: Beers & Belar, "Frequency Modulation Distortion in Loudspeakers," *Proc IRE*, Vol. 31, No. 4, April, 1943, followed by a series of papers and letters by Paul Klipsch in the *Journal of the Audio Engineering Society* between April, 1958, and February, 1970.

The writer's interest in the subject was aroused in 1947 when investigating the performance of horn loudspeakers for use in cinemas. In January, 1967, *Hi-Fi News* published a series of test results on typical loudspeakers, and in 1973 the author presented a paper at the AES Convention in New York describing the technique for measuring Doppler distortion in loudspeakers while the speaker was reproducing music and speech. This was updated in a contribution to *Wireless World* for April, 1974, and is again up-dated by the present paper. A

Anatomy of a 1/4" tape recorder

Automatic shut-off

Hysteresis three-motor drive

Electro-magnetic braking prevents tape spillage

Rugged

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10" NAB reels (or 5" or 7" standard)

Only seven moving parts

Heavy, 3/16" plate for good alignment

One-piece, 4 1/2 pound flywheel-and-capstan

Pressure brush improves contact

Computer logic permits any command sequence

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Remote record for no-thump recording

Remotable

Two channel record/playback capability. (Other models with four, two or one channels; 1/4, 1/2 or full track; playback only. Extra performance options available.)

Compare all the features of the Crown CX-824 with any other reel-to-reel recorder you may be considering. And then compare the price. Crown represents the real value.

Fast playback coupon

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A-5

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The RS4744 is the top stereo receiver in our line. And we think it looks good from any angle—value, performance and specs.

Audio magazine said "...we note that most receivers in this price range offer less power (usually 50 or fewer watts per channel) and don't have as many control features as this top-of-the-line entry from Sylvania."*

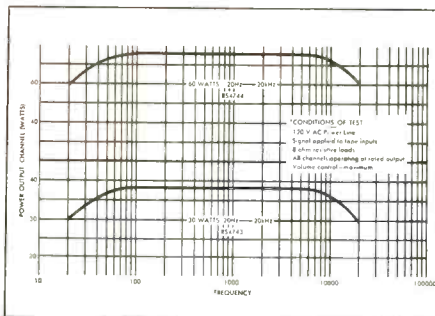
But, don't just take other people's word for it, check the specs out for yourself.

Power output of 60 Watts min. RMS per channel at 8 ohms from 20 Hz to 20 kHz with no more than 0.25% total harmonic distortion.

Three wide-range tone controls that let you tailor bass, mid-range and treble response to your speakers, room and ears.

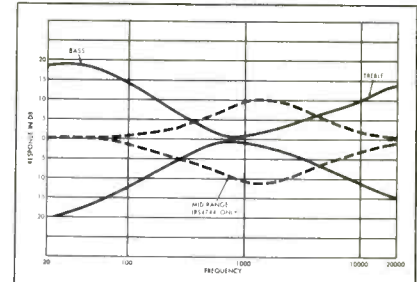
Amplifier	Rating
Power, min. RMS, at 8 ohms, 20 Hz to 20 kHz	60 Watts
Total harmonic distortion at rated power output	0.25%
FM Tuner	Rating
Usable sensitivity (IHF) 300 ohms	1.8 μ V
50 dB quieting sensitivity	3.0 μ V
Signal/noise ratio 100% mod.	67 dB

Typical specifications



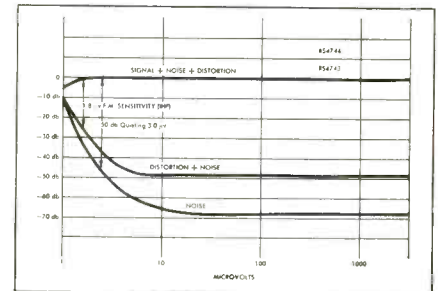
Active tone controls

Active high- and low-cut filters that have a sharp 12 dB/octave slope to reduce noise and rumble with minimum effect on music.



Tone control action

In the tuner section, you'll find features such as a phase-locked loop for long-term stability. An IHF sensitivity of 1.8 μ V and a 3.0 μ V level for 50 dB quieting.



FM Quieting

And the front panel doesn't get by on just its good looks alone. Its functionally designed pushbutton bank puts a wide range of control capabilities right at your fingertips for mode selection, scratch and rumble filters, three-stage FM muting and loudness control.



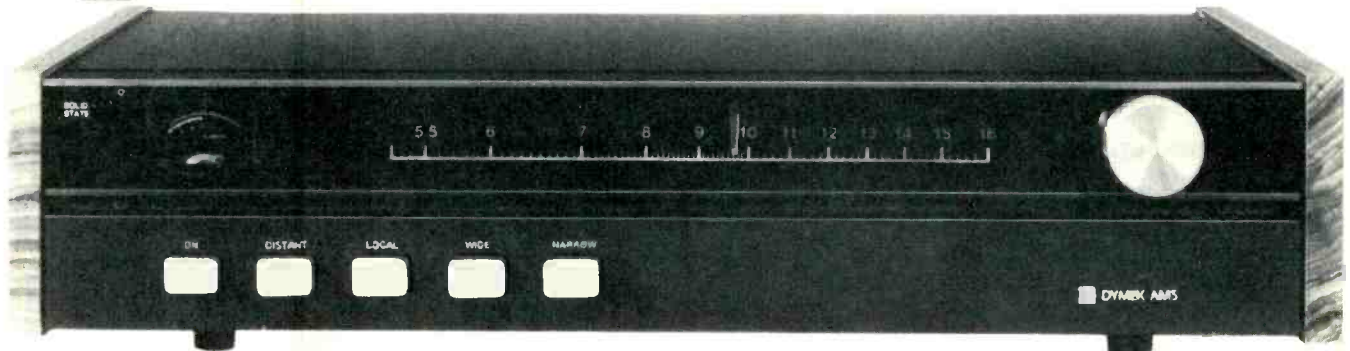
Functional design

Listen to the RS 4744 at your Sylvania dealer's today. You'll find its specs sound every bit as good as they look.

GTE SYLVANIA

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Equipment profiles



McKay Dymek AM-5 AM Tuner and DA-5 AM Antenna
MANUFACTURER'S SPECIFICATIONS AM-5 Tuner

Sensitivity: 3 μ V for 10 dB S/N.

AGC Characteristics: Less than 6 dB output variation from 10 μ V to 10 mV r.f. input level. **R.F. Bandwidth** —3 dB: Narrow, 6 kHz; Wide, 20 kHz. **Image Rejection:** 70 dB.

Adjacent Channel Rejection: 70 dB.

I.F. Rejection: 45 dB.

Frequency Response: Wide, 15 Hz to 9 kHz, —3 dB.

THD, 1 kHz Modulation: 0.5% at 30% mod.; 1.0% at 50% mod.; 1.5% at 80% mod.

Audio Output: 1 V rms, (5000 Ohm output). **Power Requirements:** 110-120/220-240 V/a.c., 50/60 Hz, 30 watts.

Net Weight: 8 $\frac{3}{4}$ lbs. (3.97 kg). **Dimensions:** 17 $\frac{1}{2}$ in. (44.5 cm) W x 3 $\frac{1}{2}$ in. (8.9 cm) H x 10 in. (25.4 cm) D. **Suggested Retail Price:** \$295.00. (Also available with balanced 150-600 Ohm output at extra cost. Supplied with wood ends or 19-in. rack mount.)

54

DA-5 Antenna

Frequency Range: 540 to 1600 kHz.

Output Impedance: 50 Ohms.

Sensitivity Adjustment Range: 40 dB.

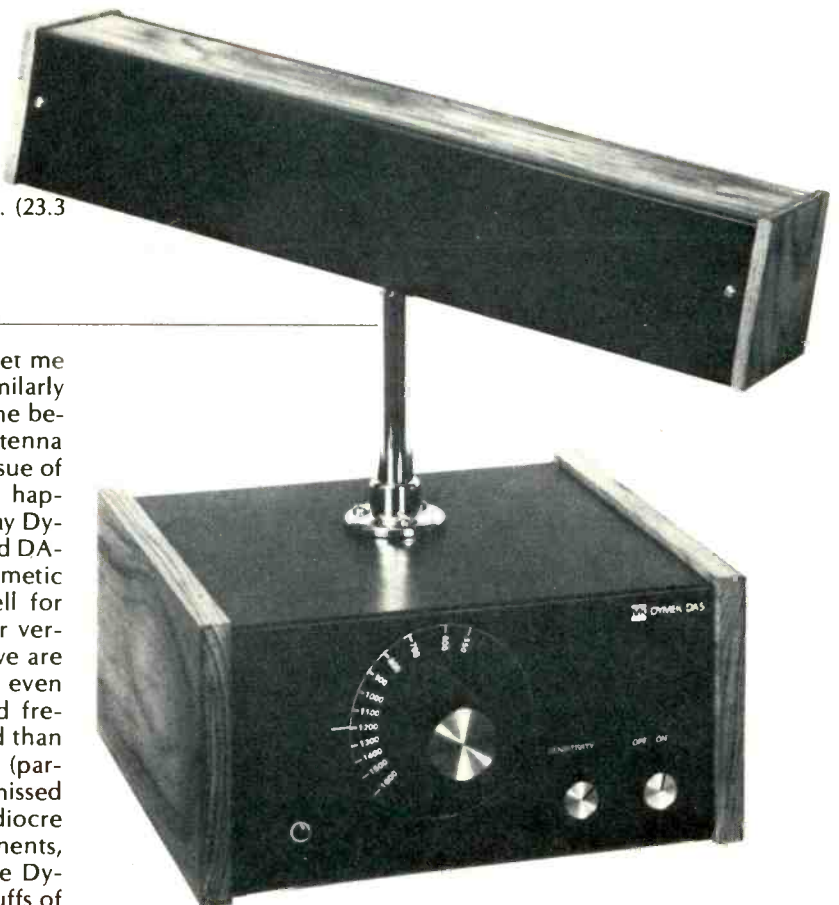
Type: Tuned preamplifier with shielded ferrite loop.

Ferrite Rod Dimensions: 12 in. (30.5 cm) L x $\frac{3}{4}$ in. (1.9 cm) diameter.

Overall Dimensions: 13 $\frac{3}{8}$ in. (34 cm) W x 9 $\frac{1}{16}$ in. (23.3 cm) D x 11 in. (28 cm) H.

Weight: 6 $\frac{3}{4}$ lbs. (3.06 kg).

Suggested Retail Price: \$175.00.



Before everyone experiences a collective *deja vu*, let me reassure you all that, yes, you have seen a pair of similarly configured McKay Dymek products in *Audio* magazine before. The McKay Dymek AM-3 tuner and DA-3 antenna were tested and reported on in the December, 1974 issue of this publication. While we do not know what ever happened to (or if there ever were) AM-4 and DA-4 McKay Dymek models, we can attest to the fact that the AM-5 and DA-5 units tested here represent more than just a cosmetic change and a price increase (the AM-3 used to sell for \$255.00, while the antenna sold for \$155 in its earlier version). As impressed as we were with the old AM-3, we are happy to advise all you AM fanciers that the AM-5 is even better. Specifically, the AGC circuit is "tighter" and frequency response is actually somewhat more extended than before. But perhaps we're getting ahead of ourselves (particularly for newer readers of *Audio* who may have missed the earlier reports). Countering the trend towards mediocre AM circuitry normally found in high fidelity components, George McKay of Pomona, California introduced the Dymek tuner (originally built overseas) to the AM-DX buffs of

America a few years ago. They welcomed it enthusiastically, confirming what they had long suspected: that AM radio can be hi-fi if a proper receiver is used and if AM radio stations take the trouble to lease high-fidelity telephone lines between studio and transmitter. Inspired by this early success, McKay now manufactures the latest version of the tuner (the currently tested AM-5) and the unusual DA-5 AM indoor antenna in the United States.

The newest version of the tuner looks very much like the high fidelity component it is. The black metal panel, framed at each end by attractive teak wood end panels, has a long, well-calibrated (if dimly illuminated) dial scale, large tuning knob, and signal strength "S" meter along its upper half. The lower left section of the panel has five rectangularly shaped metal push-buttons which turn power On and Off as well as select distant or local reception (in the local position, 30 dB of attenuation is inserted in the antenna input circuitry) and between wideband or narrow band operation of the i.f. filter.

The back panel of the AM-5 has a single output jack (Yes, Virginia, AM is still mono.), a phono-jack type AM antenna connector (for connecting a coaxial type "lead-in" wire), a pair of screw terminals for single wire antenna and ground connection, an output level control, and a pair of convenience a.c. receptacles. A slide switch permits changeover from 120-to-220 V power lines, and a line fuseholder is also located on the rear panel. The "covered over" area seen in Fig. 1 obscures the area which would contain the 150-600 Ohm balanced output option.

Construction and Circuitry

Figure 2 shows the internal layout of the AM-5 chassis. Five separate circuit board modules are used (r.f., i.f., power supply, antenna, and function selection), with a sixth added for the balanced output option (not present in our sample). A block diagram of the circuit is reproduced in Fig. 3. Following the antenna input is a dual element band reject filter to eliminate any incoming 455 kHz (i.f. signal). The switchable 30-dB attenuator (for "local" reception) comes next. A three-gang tuning capacitor is used, as are junction field effect transistors in the entire r.f. section. Cascode JFETs are used in the i.f. section, as are two ceramic ladder filters used to provide the switchable selectivity (wide and narrow bandwidth). Two double-tuned i.f. transformers also aid in establishing desired i.f. response. Separate detectors are used for audio and AGC circuits, with the former circuit employing a hot carrier diode detector. AGC voltage is derived through envelope detection and is carefully filtered before application to preceding stages. A sharp 10-kHz notch filter is included within the feedback loop of a pair of ICs in the audio section to provide 30 dB of rejection of heterodyne beats that might be caused by adjacent carrier signals. Dual polarity supply voltages are regulated by an IC.

Laboratory Performance Measurements

While existing IHF measurements standards do not recognize the "10 dB S/N" sensitivity figure published by McKay Dymek, we confirmed this measurement, obtaining 10 dB of S/N for only 2.7 μ V of signal applied. Using the more conventional sensitivity measurement technique, an input sig-

nal of 14 μ V (at 30% modulation) was required for a 20 dB S/N+THD ratio. Ultimate S/N with strong signals was better than 53 dB. Audio output level was extremely uniform at all signal strengths above 100 μ V and was "down" only 5 dB at 10 μ V input signal strength, a measure of the outstanding AGC characteristic of the AM-5. It should be noted that the sensitivity measurement was made with the "narrow" set-



Fig. 1—Back view of the AM-5 tuner.

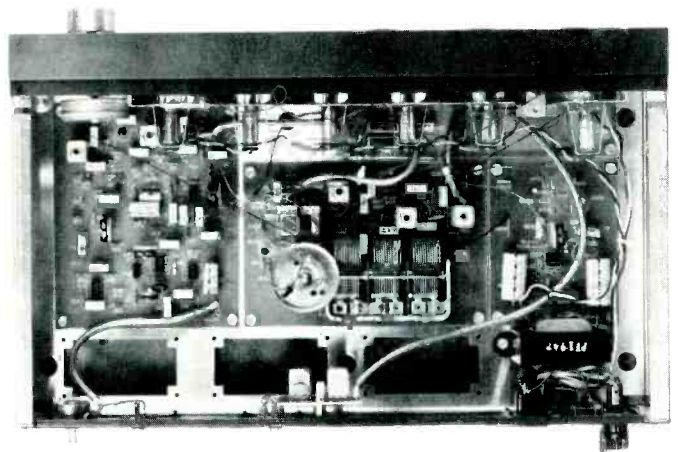
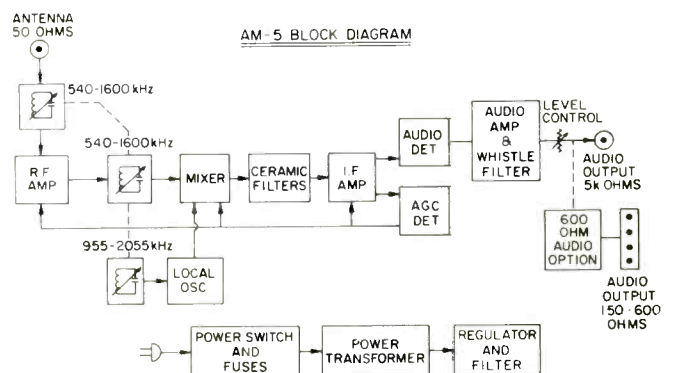


Fig. 2—Internal layout of the tuner.

Fig. 3—AM-5 block diagram.



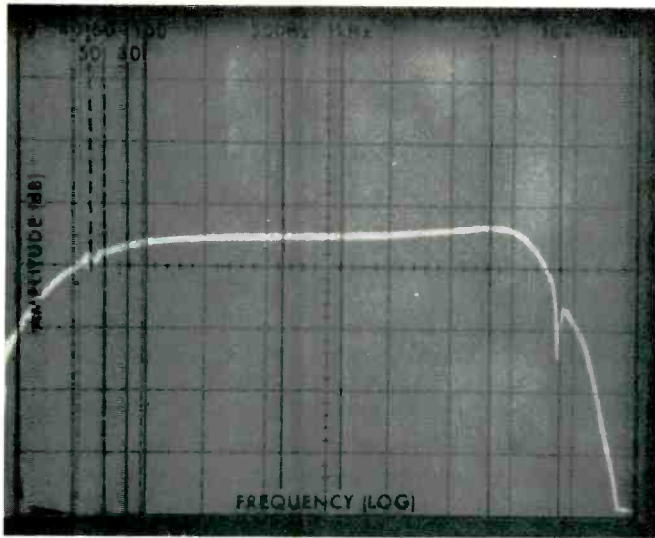


Fig. 4—Frequency with tuner set to “wide” bandwidth.

Fig. 5—Linear sweep from 7.5 kHz to 12.5 kHz shows steep rejection capability of 10 kHz “whistle” filter.

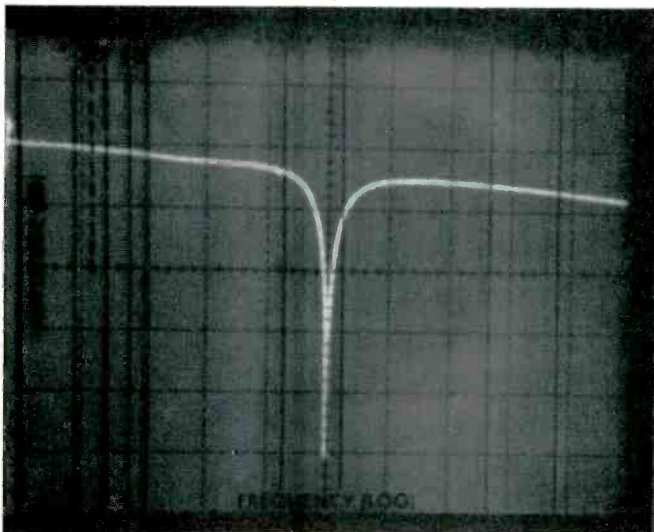
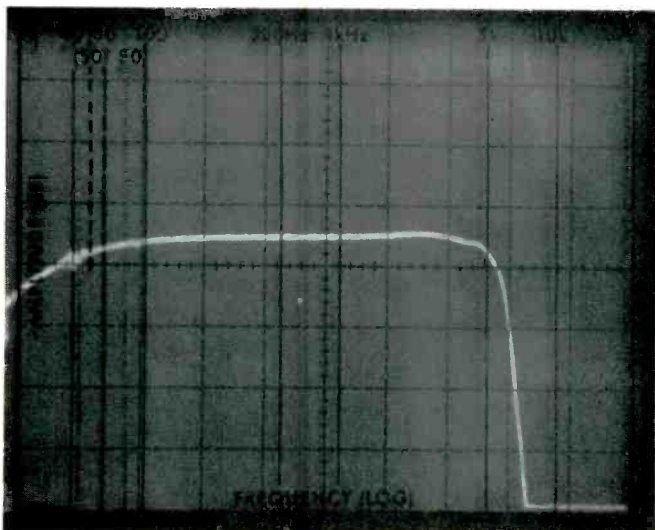


Fig. 6—Frequency response with tuner set to “narrow” bandwidth position.



ting of the i.f. section. In the wide setting, sensitivity is understandably somewhat lower. I.f. rejection measured exactly 45 dB as claimed, while image rejection was better than claimed, measuring 83 dB. Distortion, though a bit higher than claimed at the 30% modulation level (0.7% as opposed to 0.5%), behaved nicely at higher modulation levels, with 1.1% THD at 50% modulation and 1.6% at 80% modulation levels.

Perhaps the most outstanding feature of the AM-5 is its uniform frequency response all the way out to 9 kHz (in the “wide” position of bandwidth). This capability is best illustrated in the spectrum analysis ‘scope photo of Fig. 4. Note the action of the 10-kHz “whistle filter” in this trace. The filter’s notch is not properly or adequately depicted in this trace because of the relatively fast sweep rate and the logarithmic sweep used for frequency response plots on the analyzer. By slowing down the sweep and altering it to a linear sweep covering only the range from 7500 Hz to 12,500 Hz (500 Hz per division, horizontally), we were able to obtain the photo shown in Fig. 5 which shows some 40+ dB notch capability of the steep notch filter at 10 kHz.

An additional response measurement was made in the Narrow bandwidth mode of the tuner, and results are presented in Fig. 6. Even at this reduced bandwidth setting, response is still quite flat to beyond 5 kHz (probably better than that obtained on typical AM sections of most stereo receivers and tuners). As reported in our earlier test of a McKay Dymek tuner, our local full-fidelity AM station is still pumping out wide-range audio programming—a fact that we could only appreciate by listening to it with a tuner such as this McKay AM-5. If you are fortunate enough to be near an AM station that also broadcasts wide frequency response (or even if you are relatively far from one, since the AM-5 will receive stations that are further away than you would believe), the AM-5 may shed a whole new light on the capabilities of AM broadcasting. I know you will find this hard to believe, but a newsletter sent out by the McKay Dymek company contained a letter from an AM -DX'er who actually claims to have picked up the broadcast band transmissions of Radio-France Inter (not short wave, broadcast band) at 1554 kHz on his receiver, using an older version of the McKay Dymek antenna (the previously reviewed DA-3), so let's go on to discuss this second product from McKay Dymek.

The DA-5 from McKay Dymek seems to have undergone fewer changes than the AM tuner just discussed. It still has the rotatable ferrite shielded loop on top and the small box below containing a two-stage FET preamplifier which is tunable by means of a calibrated dial over the standard AM broadcast range of frequencies. A sensitivity control varies the gain of the system and a power On/Off switch (which also makes a direct-through connection to your existing outdoor AM antenna if you have one connected to your AM set) are the only other controls provided on the DA-5. Since it does contain amplifying components, it needs to be connected to a power source (either 120 or 220 volts a.c., 50/60 Hz) but consumes a mere 2 watts in use. Choice of power source voltage is made by means of a small switch on the rear panel.

Obviously, the DA-5 can be used with any AM tuner or receiver that has a terminal for connection of an external AM antenna. Equally obvious is the fact that this device cannot improve the fidelity of your present AM equipment but it certainly can and does improve overall sensitivity as well as selectivity (because of the extra stages of tuning provided ahead of your normal antenna input). Because the ferrite rod can be rotated or tilted in almost any direction, you will

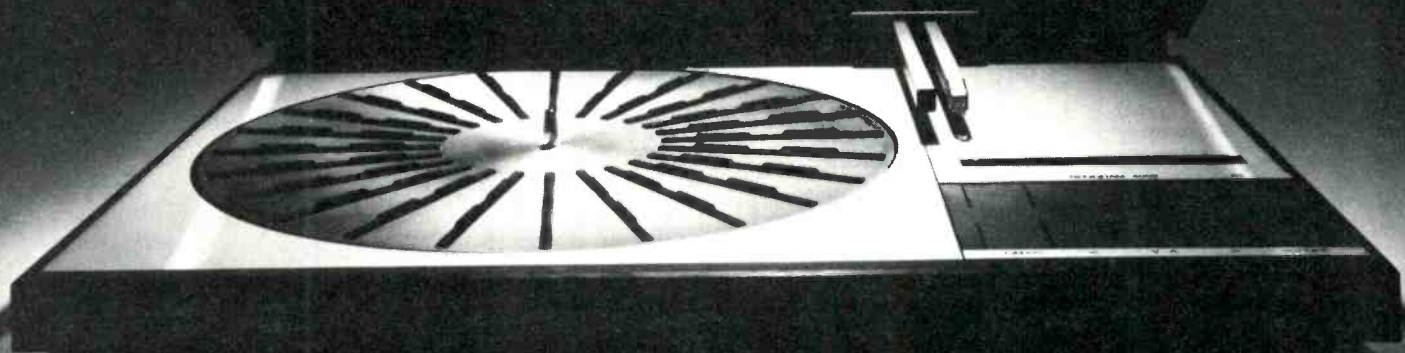
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The Beogram 4002 is a fully automatic turntable which exhibits a level of creativity and engineering skill unequalled in the field of audio components. Its tangential tracking permits the record to be played back in exactly the same manner that the master disc was cut. Electronic logic circuits, activated by a single light

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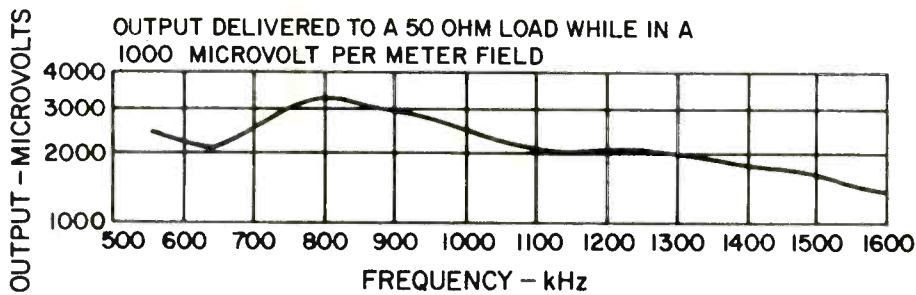


Fig. 7—Gain vs. frequency characteristic of DA-5 antenna (supplied by manufacturer).

probably find (as we did) that man-made noise can be substantially reduced when listening to AM. We were not able to make specific measurements of the "gain" of the DA-5 system, since that would have required a calibrated, known field of microvolts per meter. We are, however, reproducing a curve provided by the McKay Dymek people (Fig. 7) which represents the output delivered by the DA-5 to a 50-Ohm load over the entire broadcast band of frequencies when in the presence of a 1000 microvolt-per-meter field strength. Used in conjunction with the AM-5 tuner, this pair of products will provide you with AM reception second to none. Perhaps the most fitting way in which to summarize this report might be to quote, verbatim, the final paragraph of our earlier, 1974 test report concerning the antecedents of this current pair. The words fit even better, now.

"Certainly, the limitations imposed by AM broadcasting

techniques in general may discourage a great many audio buffs from rushing right out to spend \$295.00 (sic) for the AM-5 (sic) or even \$470 (sic) for the combination of DA-5 and AM-5 (sic). For those who enjoy AM-DX'ing, and for those fortunate enough to be served by an AM station that does broadcast wide response audio (a phone call to your favorite station's chief engineer should provide you with the needed information), here at last is a pair of products that successfully concentrates on good AM performance."

Incidentally, McKay Dymek products are sold through mail order only. You can call a toll-free number (800-854-7769 nationwide, 800-472-1783 in California) or write directly to McKay Dymek Co., North Park Avenue, Pomona, CA 91766 if you are interested in obtaining further information about these unusual products.

Leonard Feldman

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**Duntech Labs DL-15
Loudspeaker System**

MANUFACTURER'S SPECIFICATIONS

Speaker Components: One 15-in. (38.1 cm) woofer, one 5-in. (12.7 cm) midrange, and one 1¾-in. (4.445 cm) special design tweeter.

Impedance: 8 ohms, nominal.

Frequency Response: 27 to 20,000 Hz ±3 dB; 40 to 18,000 Hz ±2 dB.

Dimensions: 32 ½ in. (82.55 cm) H by 23 ½ in. (59.7 cm) W by 18 in. (45.7 cm) D.

Weight: 105 lbs. (47.63 kg) each in shipping carton.

Price: \$449.00 each.



The Duntech DL-15 is a three-way loudspeaker system. It is heavy (47.63 kg), and it is big (82 cm high, 59 cm wide, and 45 cm deep). It is one of those loudspeakers whose reproducing position in your home you should try to determine before you take delivery. The intent of this loudspeaker system is producing extremely high quality sound with no sacrifice of performance for ease of handling.

The enclosure is walnut finished and has black grille accenting the front and upper sides. A 381 mm (15 in.) woofer is used to cover the frequencies from below 40 Hz to a crossover of 350 Hz. A 127 mm (5 in.) midrange speaker covers the range from 350 Hz to 4 kHz, and a 445 mm (1 ¾ in.) tweeter takes over for frequencies above 4 kHz.

Technical Measurements

The measured magnitude of loudspeaker impedance is shown in Fig. 1, and the corresponding complex plot is given in Fig. 2. The rear-mounted tweeter control was left in the factory preset flat position for both of these measurements. Impedance variations are quite small and remain predominantly resistive for frequencies above the characteristic bass resonance peak. This speaker should present no load problems to any quality power amplifier.

The one-meter axial anechoic frequency response at one-watt average drive is shown in Fig. 3 for the amplitude of the sound pressure and in Fig. 4 for the phase. The tweeter control was set to the indicated flat position for these measurements. Bass response extends down to around 45 Hz, then rolls off smoothly. The unusual dip in response at 5 kHz, and its attendant phase change, warrants some discussion, particularly in view of the fact that Duntech measures the frequency response of each unit prior to shipment. Duntech's claim for their low frequency response is based on using a

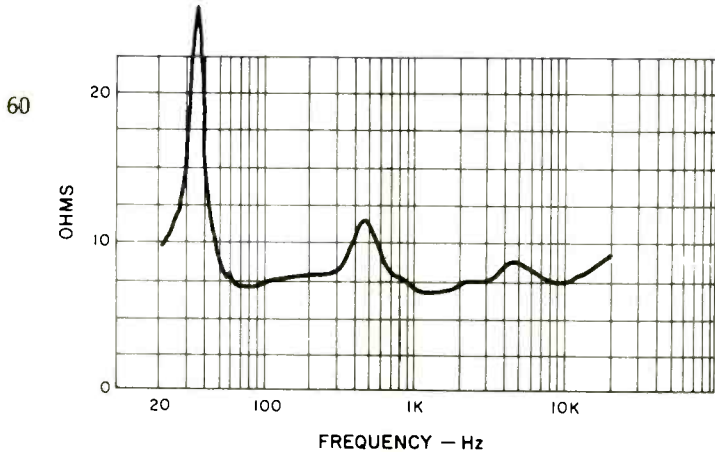


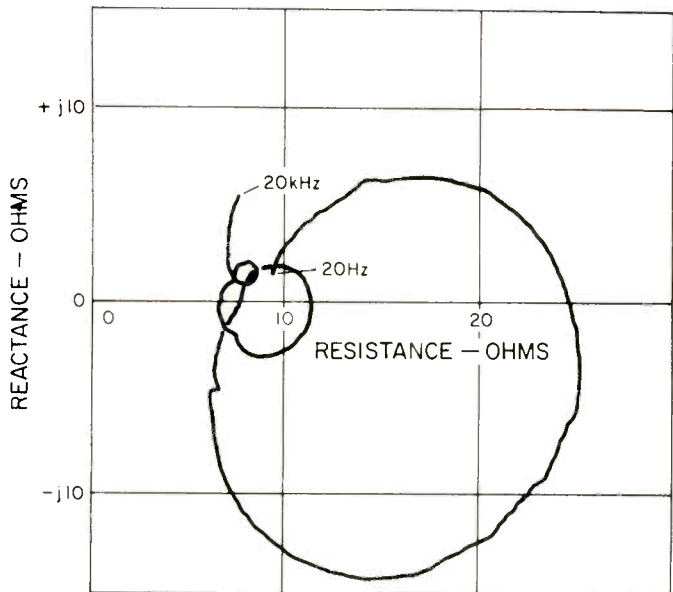
Fig. 1—Magnitude of impedance with tweeter control set flat.

Speaker connection is made to well-marked terminals placed in a recessed cavity on the rear of the enclosure. Also mounted in this cavity is a system fuse holder for overload protection and a tweeter balance L-pad. A red dot is placed on the tweeter control plate to indicate the position for flatest response, each speaker being individually calibrated.

Plastic angle brackets hold the upper grille in place and serve as edge trim on the upper front and sides. These brackets are cut off flat, leaving edges at the corners. In typical Laurel and Hardy fashion, I cut myself on one of the brackets when I grasped the enclosure to move it. My lack of grace notwithstanding, I hope that Duntech will smooth or remove these edges on subsequent units.

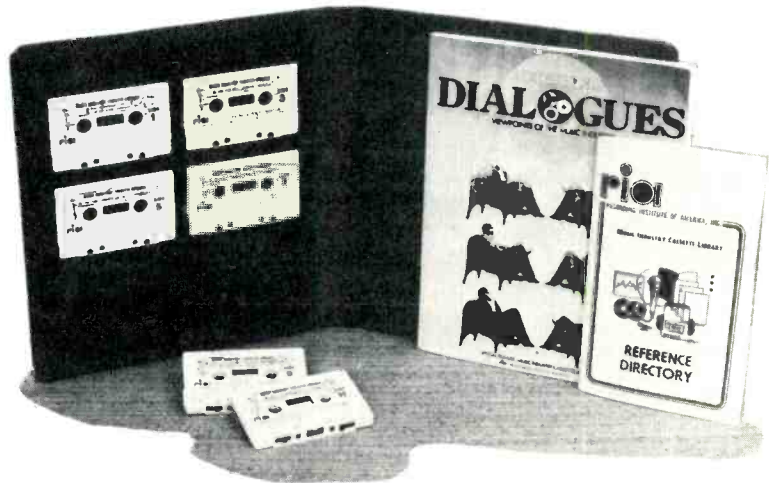
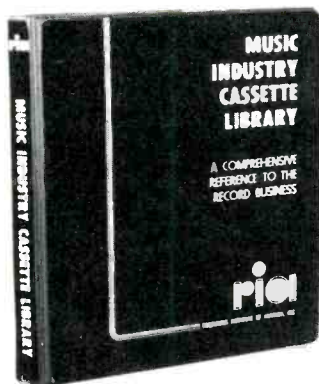
Duntech supplies a very thorough and readable instruction manual with each speaker. This covers both technical details and helpful suggestions on room placement for best sound. The DL-15 loudspeaker system carries a five-year, transferrable, full warranty against manufacturing defects.

Fig. 2—Complex impedance, tweeter control set flat.



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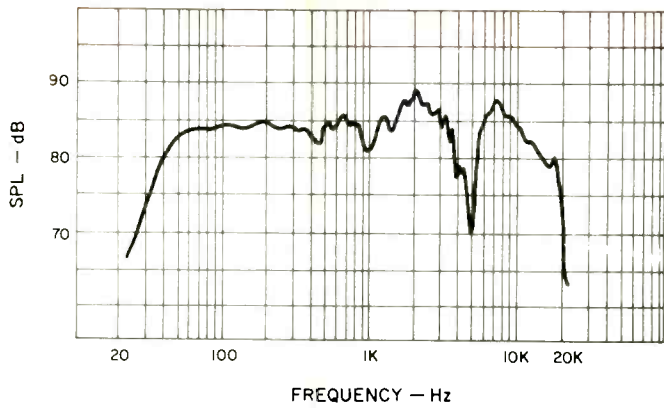


Fig. 3—Anechoic one-meter axial sound pressure level for one-watt average drive.

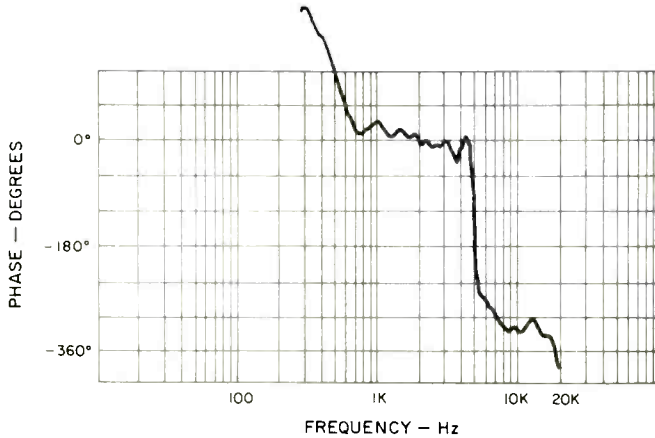


Fig. 4—Anechoic one-meter axial phase response.

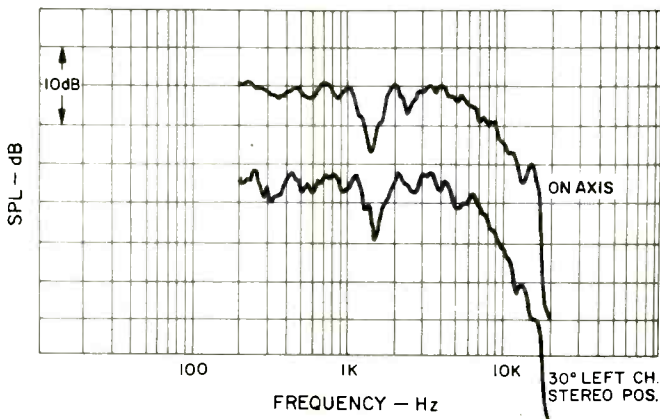
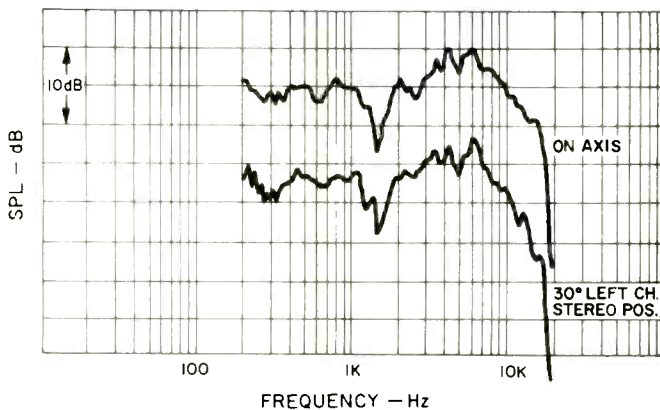


Fig. 5—Three-meter room test, tweeter set flat.

Fig. 6—Three-meter room test, tweeter set to maximum.



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two-boundary measuring condition (wall and floor), which they believe more nearly approximates normal home listening conditions. *Audio* measures the response directly on the geometric center line of the speakers, with no "preferred" positions, and everybody gets the same treatment. It just happens that this is about the worst position for the Duntech. Moving the microphone a bit up to be aligned with the tweeter or down to be in front of the woofer substantially smooths the measured response, but the response shown in Figs. 3 and 4 is what the center-line measurement yields.

The acoustic transition between midrange and tweeter accounts for the dip in response at 4 to 5 kHz and nearly 360 degree shift in phase. The phase measurement was made with a time delay offset corresponding to the air path delay from midrange driver to microphone. The phase shift below 600 Hz is due to the woofer, which has an acoustic position behind the midrange driver and hence a longer time delay. With the exception of the phase changes around 600 Hz and 5 kHz, the Duntech DL-15 is principally minimum phase.

Figure 5 shows the measured three-meter room response. The DL-15 was placed on a carpeted floor and against a wall, as recommended by Duntech. A microphone position three meters from the front of the enclosure and one meter above the floor is used to simulate a normal listening position. The tweeter control was set to its indicated flat position. Two measurements are shown, one directly in front of the enclosure and the other angled 30 degrees for the Duntech in a normal left-channel stereo position; the plots are displaced 10 dB for clarity. The response is quite smooth throughout the frequency range but begins to drop above 7 kHz, though it extends smoothly to 18 kHz. (Editor's note: This high end drop, says Duntech, with distance was intentional. It is based on their contention that the same drop is evident with most musical instruments and the human voice due to a reduction in angular dispersion at frequencies higher than about 4 or 5 kHz.)

In order to check the top end drop, the measurement was rerun with the tweeter control in its maximum position, with the results shown in Fig. 6. It appears that the tweeter control should be left in its flat position as a 6-kHz peak occurs when the control is placed in its maximum position.

If you want to pull the top end up for a more uniform direct source sound, an equalizer should be used which pre-emphasizes the frequencies above 5 kHz. An octave band equalizer may do it, but a normal pre-amplifier tone control will not and should be left in the flat position.

The polar energy response is shown in Fig. 7 for horizontal dispersion and in Fig. 8 for vertical dispersion. This is a measurement of the total sound energy density for all frequencies equally weighted from 20 Hz to 20 kHz. The three curves are for the rear-mounted tweeter control in its minimum, flat, and maximum position.

The horizontal polar pattern is quite symmetric with almost no left or right dominance of sound. The vertical polar pattern, particularly in the flat position, shows a mild upward dominance of launch angle for sound with a minor notch on axis. This verifies the axial frequency response measurement difficulty we encountered in the anechoic test. The room tests, shown in Figs. 5 and 6, have a microphone position above the enclosure's geometric axis and thus are made in the major vertical lobe of Fig. 8. This is why the 5-kHz notch did not show for an average room listening position. (Editor's note: Duntech points out that the smoothness of the polar plots is, in large part, due to the use of foam around the midrange and tweeter units. Used in this manner, says Duntech, the foam also prevents diffraction effects which take their toll on the sharpness of transients.

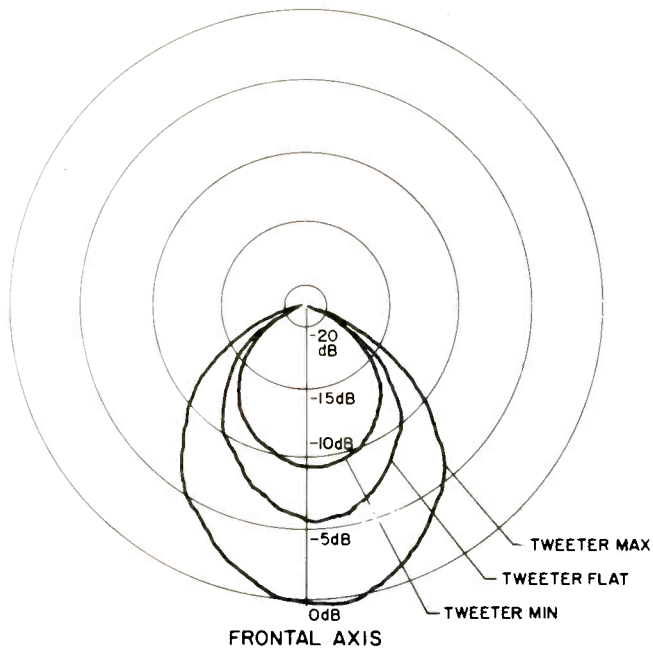


Fig. 7—Horizontal polar energy.

Fig. 8—Vertical polar energy.

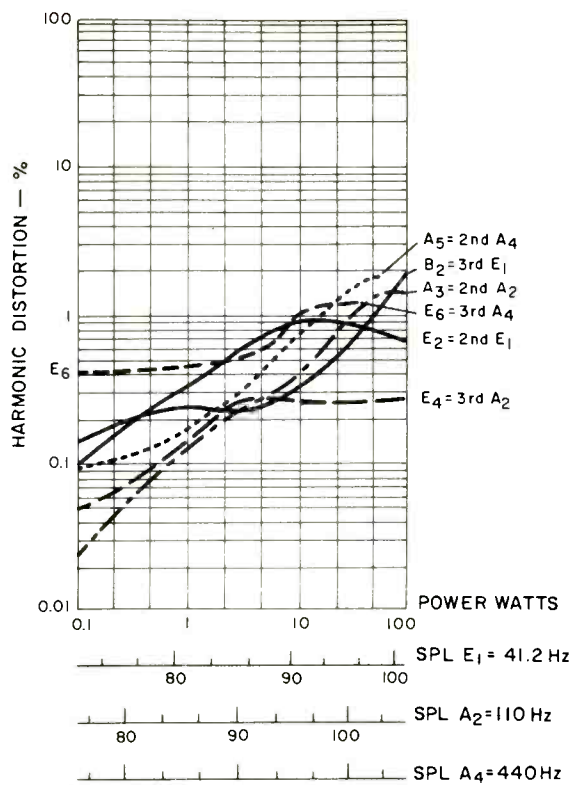
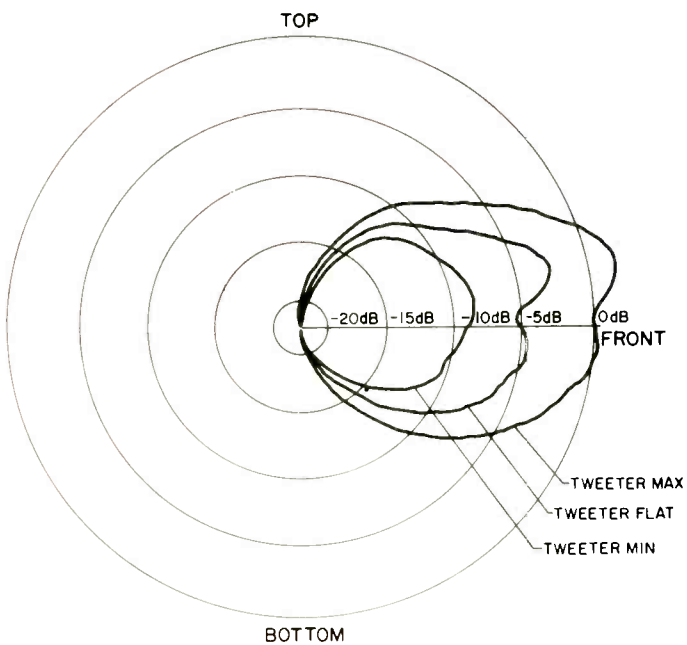
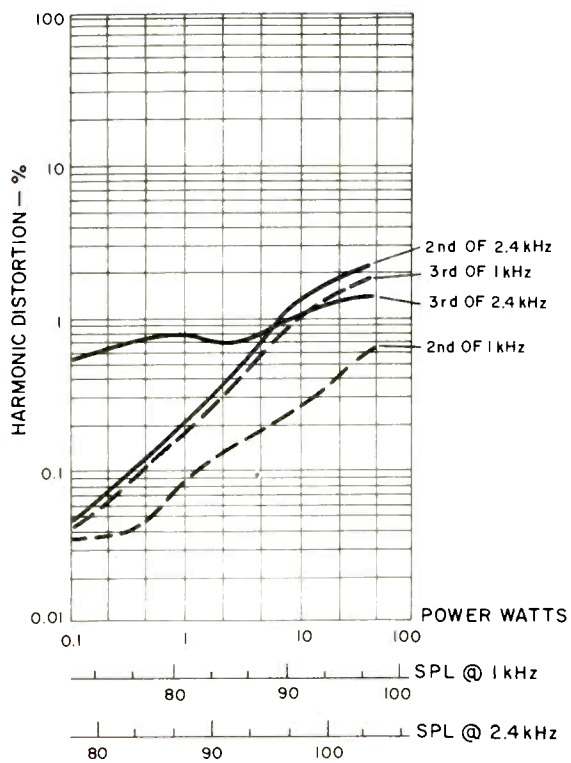


Fig. 9—Harmonic distortion for musical tones E1 (41.2 Hz), A2 (110 Hz), and A4 (440 Hz).

Fig. 10—Harmonic distortion for the tones of 1 kHz and 2.4 kHz.



The success they achieved can be judged from the sharp peak in the energy-time plot shown in Fig. 12.)

Harmonic distortion for the musical tones E1 or 41 Hz, A2 or 110 Hz, and A4 or 440 Hz is shown in Fig. 9. The low bass (41 Hz) distortion, usually where most distortion occurs, is quite low, right up to the 100-watt level, where it is just reaching 2 per cent.

During the earlier listening test, it seemed to this reviewer that the upper midrange frequencies, particularly around 3 kHz, were reproduced with a mildly strained quality suggestive of nonlinear distortion. During later measurements on these speakers, we went looking for it with the aid of a spectrum analyzer and found that the midrange driver has difficulty handling the spectrum around 2.4 kHz. Figure 10 shows the second and third harmonic distortion for the frequencies of 1 kHz and 2.4 kHz. The fourth and higher order harmonics lie well below these levels.

The Duntech woofer crosses over at 350 Hz, which is approximately F above middle C. In order to check for woofer intermodulation, we used E1 or 41.2 Hz and middle C, 262 Hz, approximately one-half octave below the crossover frequency. These were mixed in equal ratio and the crossmodulation of C4 by E1 measured and the results are shown in Fig. 11. The nature of this intermodulation is principally amplitude modulation of C4 by E1 up to high levels, then an ad-

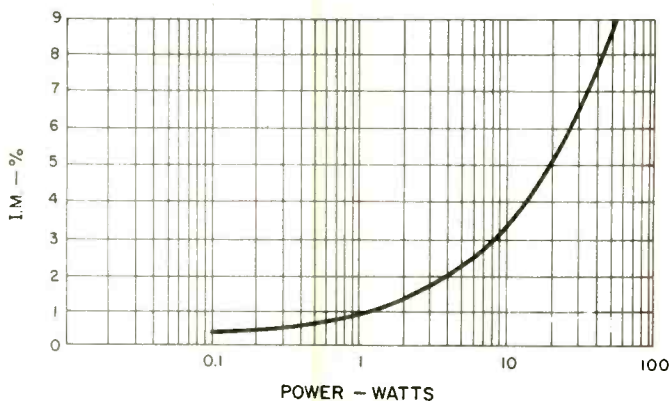
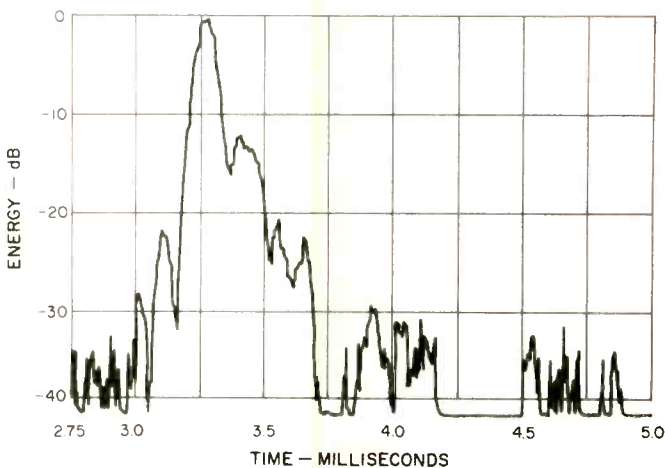


Fig. 11—Intermodulation on middle C (262 Hz) produced by E1 (41.2 Hz) when mixed 1:1.

Fig. 12—Energy-time curve.



ditional phase modulation occurs at the highest levels. At 40 watts average drive, for example, the peak-to-peak phase modulation is about 10 degrees and the peak-to-peak amplitude modulation is about 5 per cent.

The energy-time response, which is the logarithmic magnitude of the impulse response, is shown in Fig. 12 for the one-meter axial position. The anticipatory peaks at 3.0 and 3.1 millisecond are computer artifacts caused by the rapid phase change of the loudspeaker response at 5 kHz. The actual sound pressure level commences at 3.16 milliseconds and peaks accurately at 3.26 milliseconds, as shown here.

The tweeter and midrange start their separate impulse responses at the same time, but because the tweeter has peaked its arrival energy before the midrange unit, there is a residual response from the midrange driver extending to 3.7 milliseconds. Diffraction peaks occur at around 4.0 and 4.6 milliseconds, but they are minor. The first arrival at 3.26 milliseconds has a spectral dominance at around 8 kHz, and the spectral peak at 3.4 milliseconds is around 18 kHz. The spectral components at 3.6 milliseconds are principally 3 kHz and are due to the midrange driver.

Listening Test

In order to assess the listening quality of the DL-15s, they were mounted exactly as recommended by Duntech, flat against a wall and subtending an angle of 60 degrees relative to the listening position.

My overall impression of the reproduced sound quality is that the response is well balanced and extended, with good high and extreme low frequencies. The extra low bass seemed somewhat prominent, and a mild drop in bass level by preamplifier tone control was felt to help out a bit. I found that I wanted a mild high frequency pre-emphasis for some musical material, particularly vocals and brass.

In my opinion, the only detraction from otherwise superior reproduction is a touch of stridency in the midrange, from 1 kHz to 5 kHz, at high sound levels (above 95 dB SPL), which stands apart from the clear bass and extreme top end. This was particularly noticeable on vocals. In my earlier listening notes I commented that there is some distortion at around 3 kHz, which the technical measurement showed was at 2.4 kHz. I also sensed a moderate peak at 100 to 200 Hz in the response, which may be due to the flush wall placement of the enclosure.

Stereo imagery is good, both for lateralization and a sense of depth. There is, however, a change of timbre with listening position, and this results in a small amount of space wandering of center-positioned stereo images as one moves about the listening area.

I consider that the DL-15 has one of the most accurate reproductions of a piano which this reviewer has heard from commercial speakers thus far. The spectrum up through the octave above middle C is clean and free of audible peaks, and the 100 to 200 Hz "room bump" can be readily softened by tone control equalization.

The low bass is reproduced quite firmly with only the slightest evidence of bass hangover on percussion.

I found the DL-15 totally unforgiving of any substantial sound absorbing object near the front of the enclosure. The area immediately near the front of the enclosure must be clear of objects or the stereo illusion goes to pot.

The Duntechs need a good, big power amplifier if you like your sound loud; a Marantz Model 510 handles them quite well. And you need a good-sized living room to make use of the bass response which the speakers are capable of achieving. If you've got that, and some clean recorded material, you can sit back and enjoy some truly good sound with a pair of DL-15s.

Richard C. Heyser

Check No. 91 on Reader Service Card

The column

Black 'n' Blue: Rolling Stones
Rolling Stone COC 79104, stereo,
\$6.98.

Those grand old debauchers of the musical scene are back with another new/old album, and like the last, **It's Only Rock 'n' Roll**, it's produced (and thereby dominated) by Mick and Keith, known to some as the glimmer twins. Ron Wood is only present as a charter member, having joined the group after a majority of the tracks were cut, and even when he does play, he adapts to the Rolling Stones guitar sound, rather than being his own stark self; Charlie and Bill usually sound the same but don't have much presence and personality on record than the section rhythm section you'd find in L.A. or N.Y. (and which were rumored to have played on several Stones records in the past). So the main thrust of any criticism should be leveled at Jumping Jack Jagger and his henchman Keith.

My criticism is the same as with **Goat's Head Soup** and most of the post Oldham/Jones albums—there is little excitement, the spirit of fun and fighting has gone, and the records are dominated by a pretentious effort to retain the Stones Sound, yet remain *au courant*. This record isn't nearly so premeditated as the others, probably due to the extensive use of drugs during the recording—The Rolling Stones have never sounded so much like they'd rather sack out than play. Not only do they sound like they were asleep during the recording of this album but also while they wrote the songs—the only really decent songs on **Black 'n' Blue** are *Hand of Fate* and *Crazy Mama*, neither of which has the sting of *Honky Tonk Women*, never mind coming close to the punch of *Satisfaction*.

This is the Stone's R&B album, which means they get away with recording non-songs like *Hey Negrita* and *Hot Stuff*, which are basically your typical dumb lyrics repeated over mediocre riffs. They can lay back in their chairs on *Melody* and let Arif Mardin's horn arrangements pick up the slack, they can fall on their faces with *Fool To Cry* and claim it's the next *Angie*. They've done a nice job on a tra-

ditional reggae tune *Cherry Oh Baby* but it's nothing spectacular, and people might say that *Memory Hotel* is the next *Till The Last Goodbye*. But that's using a rather lame song as the basis of a critical analysis, and the truth is, **Black 'n' Blue** is far more vacuous than the pleasant-but-innocuous **It's Only Rock 'n' Roll**. The Rolling Stones should either start taking more care with the making and creation of their records, at least as

from a historical point of view but is also the best collection of Rolling Stones songs released in the U.S. in seven years. Behind a statement like that lie some fairly meaty arguments (often challenged by today's Stones fans), so explanation is in order.

One must ask who the Rolling Stones are, to determine if they are better today than they were yesterday (or more importantly, whether they are *more* Rolling Stonesish today than



much care as was taken with the resurrections on *Metamorphosis*. . . or maybe get Andrew Oldham to produce them. *Jon Tiven*

Sound: B — Performance: C —

Metamorphosis: Rolling Stones
Abkco/London ANA 1, stereo, \$6.98.

Made In The Shade: Rolling Stones
Rolling Stones/Atlantic COC 79102, stereo, \$6.98.

Both of these albums purport to be definitive statements of what the Rolling Stones are/were during a particular period, and serve to show to all the world the Rolling Stones' singles (**Made in the Shade**) and their early closet tracks (**Metamorphosis**). However, **Made in the Shade** is utterly useless, while **Metamorphosis** is not only the most interesting Stones record

before or less so). The Stones were a combination of four ingredients: Mick Jagger (lead singer/songwriter), Keith Richards (lead songwriter/guitarist), Brian Jones (lead artist/multi-instrumentalist), and Andrew Oldham (producer/lead puppeteer, mastermind). The interaction of these four distinct personalities made the Stones different from every other rock/r&b group around, a difference which kept them on top of the rock (with competition only from the Beatles) as long as the group was intact. Andrew Oldham was the first Stone to roll on (right after the **Dandelion/We Love You** single)—for several personal and musical reasons. The group was significantly weakened, but with the three left there was enough room to produce a decent album, **Beggars' Banquet**, although it couldn't begin to compare with their earlier albums except as it projected Mick Jagger as a

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fast-jiving Satan, which readily ap-
pealed to the American sense of
bloodlust. But when Brian Jones left
the band (and the world of the living)
the Rolling Stones were no more.
Though the Jagger and Richards team
could superficially lay claim to being
responsible for the Stones sound, the
soul of the Rolling Stones belonged to
Brian and Andrew. The result has
been a series of albums which were
not only dull, moronic, and empty,
but which have been promoted to the
point where many people actually be-
lieve that the Rolling Stones are the
greatest rock 'n' roll band in the
world. This came about from hypes
performed by their management, and
their sharing the same moniker as
America's number one rock maga-
zine. It's amazing what a good public-
ist can do when the music has run out.

Made in the Shade is a tight, polish-
ed document of the past five years of
Rolling Stones music—bland blues
progressions with semi-decadent lyr-
ics, weepy ballads, and a hit single or
two. Very tedious stuff that we've all
heard a thousand times before.

Metamorphosis, on the other hand,
is the meat of the Rolling Stones. Be-
cause what this album is is a collection
of the songs which the Rolling Stones
decided not to release for various rea-
sons: some too openly expose their
bisexuality, some are too pop-orient-
ed, and a few are blatant steals from
other songs. Just a partial picture of
what's hidden in the vaults of the
Rolling Stones, taken out of the gar-
age years after the fact by ex-man-
ager/producer Andrew Oldham and
brought back into the studio for an
overdub or two. Yes, the original mas-
ters were slightly tampered with (rather
obvious to any listener), but the
post-mortems were done with the
same purpose as the original record-
ings: *let's have some fun!* Side one is
material originally recorded with An-
drew at the knobs between 1963 and
66 (so they say) and side two is a
bunch of tracks cut when Jimmy Mill-
er was producing them, all mixed and
remixed by Oldham over the past few
years.

A track-by-track analysis is in order.
Out of Time was originally on the
Flowers album in America (recorded
around the time of **Aftermath**), but
this is a different take, full of grand or-
chestration. In fact, it was originally
recorded as the backing track for the
single by Chris Farlowe (a hit in En-
gland) and I'd guess that Jagger's vo-
cal was merely put on as a reference
for Farlowe to follow. One of the best
Jagger/Richards compositions ever,
this version features an offhand and

classic vocal by Jagger, who seems less
self-conscious than usual, probably
because he figured it'd never see the
light of day. *Don't Lie to Me* is a
Chuck Berry song (at least that's the
song credited to Chuck which ap-
peared on **Berry's Golden Decade
Vol. 2**) probably recorded about
the same time as **The Rolling Stones
Now** (a great bass line, guys). *Each &
Every Day of the Year* is a demo the
Stones did for another group pro-
duced/managed by Oldham and re-
leased as a single, a very pretty song
with a mildly off-key but charming vo-
cal. The only throwaway on side one is
a rather tepid rendition of *Heart of
Stone* featuring crummy drumming
and a raunchy solo by a young Jimmy
Page—Pagey sounds like he just got
through with a Kinks session and left
his chops at home. However, the next
track is an absolute winner written by
Oldham/Richards on an Australian
beach, a hilarious little gem titled *I'd
Much Rather Be With the Boys* featur-
ing Andrew Oldham on lead produc-
tion and Mick Jagger on out-of-tune
vocals. The next track is a killer as
well, very un-Stonesish (I'd suspect it's
another demo) and seemingly Spec-
toriffic (cute lyrics, too). It's *Walking
Thru the Sleepy City*, a good one. The
last on side one is *Try A Little Harder*.
It's an *Aftermath* outtake that's OK
even if it sounds a little bit too much
like an R&B song (whose title escapes
me). All in all, a fine assortment of
tunes—more worthwhile stuff than
you'll find on **Made in the Shade**,
hands down.

Side two was recorded later (1969?)
and by now their writing talents had
dissipated more than just a little bit.
The songs are less than classics, I re-
gret to report, but they're still darn
good. *I Don't Know Why* (written by
Stevie Wonder) is listed as featuring
Mick Taylor, but it doesn't sound like
him to me. Andrew Oldham's post-
production on this one is terrific. As a
matter of fact, the man deserves a spe-
cial award for his major surgery on
most of these tracks because, from
what I've been told, the original tapes
were all but unlistenable. *If You Let
Me* sounds like it was recorded during
Beggar's Banquet (shades of *Factory
Girl*) but written earlier (*Sittin' on a
Fence* comparisons are obvious). *Jivin'
Sister Fanny* is a Keith Richards Spe-
cial—the vocal by Jagger is mostly off-
the-cuff, and the music is straight
Rock 'n Roll. Bill Wyman gets his first
composing credit since *In Another
Land* on *Downtown Suzie*, a rather
drunken ramble full of groans and
strange noises. Mick parades his deca-
dence on *Family*, not one of the

stronger tunes on the album but interesting (great enunciation, Mick). *Memo From Turner* is a throwaway, far inferior to the Ry Cooderized version which appears in the **Performance** movie, and is useful only for its lyrics. The final word on the album is *I'm Going Down*, a strong rocker from the Jagger/Richards/Taylor pen with unintelligible lyrics, I'm happy to report. There's nothing so embarrassing as Mick Jagger with nothing to say, trying to verbalize his thoughts.

Anyhow, if you're any kind of Rolling Stones fan you will have no use for **Made in the Shade**, as you've probably got all the songs already, and they're not so good anyhow. **Metamorphosis**, though, will at the very least intrigue, and probably will excite you. If you gave up on the Rolling Stones when they left the 60s, pick up on **Metamorphosis**. It'll let you know why they were what they were, and why they aren't anymore. *Jon Tiven*

Shade Sound: B Performance: C-
Meta. Sound: A Performance: A

Sunburst Finish, BeBop Deluxe
 Capitol ST-11478, stereo, \$6.98.



Bill Nelson is an extremely able guitarist and he knows it—he intimates it in his lyrics, he brings his guitar right up front in his mix of his albums, and he'd have to be deaf not to realize that simple fact. But if that was all he could do, *BeBop Deluxe's* albums might be as boring as, say, David Bowie's. However, Nelson is not infatuated with his guitar wizardry, though he is arrogant with his axe and anxious to show off his wizardry; no, Nelson is a highly intelligent, articulate, and well-heeled guitar hero who doesn't preach with his albums but asks questions, who doesn't walk blindly into each album but proceeds cautiously, taking just the number of steps he can without tripping over his own feet. **Sunburst Finish**, the third album by Bill Nelson's *BeBop Deluxe*—and it's fairly obvious whose group this is—is coproduced by Bill, features several songs written by him, and will obviously be compared to Queen (because of the guitar

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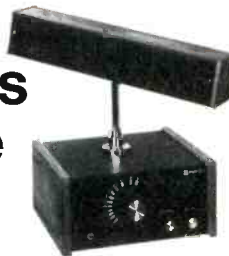
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sound) and Bowie/Cockney Rebel (due to the vocal inflections). The record is very enjoyable and even thrilling at times, my only gripe being that the new territories aren't as challenging as those on the last LP, nor are the songs different enough from those last time. **Sunburst Finish** is instead a refinement of those styles touched upon before, which one hopes will bring Nelson's talents to the attention of the masses.

There are a few faults with the album—the last two albums sounded equally astounding on transistor rardrous. His sexual references are more bum has a production quality which lends itself more readily to a smaller speaker (the voice seems to get lost when the album is played through huge speakers). Also, the one factor which probably puts an audience off to Nelson is his lyrical pretention, which is not only less than subtle but which borders on the self-conscious. At times his poetry works, but more often it comes across as less than wondrous. Hix sexual references are more amusing than his guitar hero talk, and hopefully by the time his next album comes out he'll have found his audience and won't have to make things quite so obvious. Also, there was one song which BeBop released as a flip-side, *Lights*, which had an amazing quality of spaciousness which BeBop Deluxe has never attempted again, and this vein could be pursued to some extent on future recordings.

Anyhow, this is one of the better records I've heard lately, and a credit to Bill Nelson's flourishing reputation as one of the few guitarists exploring new territories. I'd think he'd develop into one of the major musical figures of the Seventies with a little help from his record company. *Jon Tiven*

Sound: A — Performance: A —

Ba-Fa: The Hudson Brothers
Rocket PIG-2169, stereo, \$6.98.

Some of my colleagues have argued that The Hudsons could be the next Beatles with their clean look, clean sound, and clean image. I don't even think these guys could be the next Badfinger, never mind the next Beatles. This reviewer was unfortunate enough to catch The Hudsons at the Bottom Line in N.Y.C., and their act has got to be the crassest, most artificial, and the least lifelike show in the world. They've got about as much rock 'n' roll spirit as Percy Faith.

I do believe they've studied their Beatles chord progressions very hard,

AUDIO • AUGUST, 1976

and have learned to plagiarize from them while adding as little of their own elements as possible. *This* only mildly annoys me. But when they're on Hollywood Squares and try to out-wit Paul Lynde, they try my patience. The only way anybody could stand them is without looking at them, and as their appearance seems to be the prime basis of their appeal, I can't see this group making any headway in the rock world. The Hudsons have sold out too many times to be credible, and their music is a far cry from being incredible.

Jon Tiven

Sound: B Performance: D+

David Courtney's First Day: David Courtney
United Artists UALA553G, stereo, \$6.98.

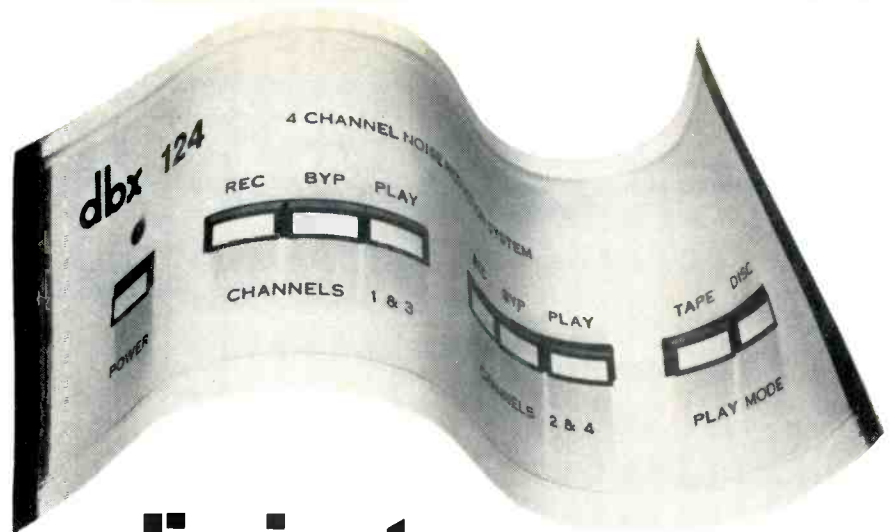
The premise behind the making of this album was a sound one. Leo Sayer has become a successful star and a hot talent in songwriting as well. It so happens that Leo writes only the lyrics to Courtney's songs, who in turn provided the music until recently. Courtney split, Sayer found a new music composer, and the quality of Sayer's songs fell drastically; it was only natural that someone would scoop up Courtney as a talent unto himself.

However, it was foolish to assume that Courtney alone would be as much of a find as Sayer. Sayer's voice is extraordinary, while Courtney's is at best fairly good and at worst mannered and misapplied. What's more, Sayer's lyrics provided structure, focus, and proper rhythms for Courtney's melodies and chord progressions, and the value of this should not be easily cast aside. Lyrics are not just words in rock 'n' roll, they key the beat of the song, and Courtney is simply not as competent as Leo. Courtney is forced where Sayer was free and flowing, and his lyrical ideas can't match Leo's—the best explanation for Courtney's flaws is that he's young, very early in the development of his abilities as a self-contained artist. His voice has all the flaws of someone not used to singing, and his lyrics sound like the lyrics someone would write when he was just beginning. Courtney may some day develop into a major rock artist, but right now his career seems premature.

There are a few delightful moments on his debut album—*Don't Look Now* and *My Mind* the most obvious—but he seems a more capable singles artist than an album man at present.

Jon Tiven

Sound: B Performance: B-



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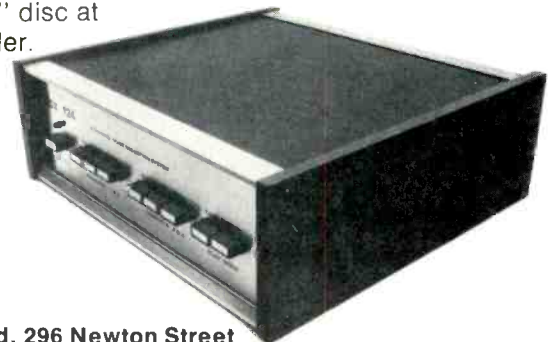
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Brahms: Sonata No. 3 in F Minor; Rhapsody in G Minor. Bruno-Leonardo Gelber, piano. **Connoisseur CSQ 2084**, stereo/quadrasonic, \$6.98.

Ingus Naruns, cellist. (Bruch, Medins, R. Strauss.) Anatols Berzkalns, pf. **Kaibala 60F01**, stereo, \$6.98.

Ragas of Meditation and Happiness. Vasant Rai, sarod; Alla Rakha, tablas. Kokila Rai, tamboura. **Vanguard Everyman Nomad SRV 73013**, stereo, \$3.98.

Kurt Weill: Three Penny Opera Music (Kleine Dreigroschenmusik). Kurka: The Good Soldier Schweik. Music for Westchester Symphony, Landau. **Vox Candide CE 31089**, stereo, \$4.98.

Stravinsky: Mass. Poulenc: Easter and Christmas Music. Choir of Christ Church Cathedral, Oxford, Preston. **Argo ZRG 720**, stereo, \$6.98.

Monitor has a winner in this huge 5-act opera recording out of Bulgaria even if it is the sweetened-up Rimsky version. (M. himself finished only a vocal score; R.K. orchestrated it, removing the "barbarisms" that were the best part.) Such gorgeous solo singing, huge big voices—such powerful chorus music, omnipresent! And such a very real intensity and musicianship. Nothing jet-international about *this* opera making, and it's the better for it. Beautifully recorded, too. By the Russians, I presume.

This EMI import, unlike those from Klavier is marked SQ, a single-inventory quadrasonic release. (Question: are Klavier's EMI discs SQ unannounced? The EMI originals definitely are, in the British release form.) Gelber is again a first line Romantic pianist, really communicating this big, splashy, noisy youthful Brahms without overdoing it. Odd—a trace of edginess (says my stylus . . .) in the main recording, a cleaner, more solid sound in the added Rhapsody, last of side 2. Wot happened?

The Kaibala label is predominantly Latvian-American and this cello/piano team is excellent, their biggest problem being the Latvian language which, like Czech, is plastered with sprouting accent marks. (We omit them—printers never heard of them.) Naruns is a fine cellist, playing warmly a really beautiful, clear melodic line, in tune; Good piano, too, if microphoned a bit in the background (he is unwisely listed as "accompanist"). *Extremely* quiet surfaces, totally minus rumble—a phenomenon!

Maybe all Chinamen once looked alike to us Westerners, but no longer the sound of Indian music (!) though the format is always superficially the same, slow introductory improvising, a gradual rhythmic speeding and thickening on an easily audible scale (mode) and a tricky longish pattern of repeated beat-groupings. Two shorter pieces here (arbitrarily boiled down?) seem too short, get there too fast; the single long one on side 1 has the right hypnotic cumulation of effect, I'd say.

It's always a pleasure to hear the *Little Three Penny Music* suite, out of the famed 1920s opera about Mack the Knife, et al., so charmingly authentic in its 1920s plunks and blats and grunting saxes. Landau's Westchester players don't try to exaggerate—good. Too many do. The much later (1956) Kurka, on a related post-WWI theme, is rather more out of Shostakovich plus American Academic, smoothly pro and facile at too much length. I'll take Weill.

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Classical reviews

Edward Tatnall Canby

Mahler: Symphony No. 2 "Resurrection." Fassbaender, Price, London Symphony Orch. and Chorus, Stokowski.

RCA ARD2 0852, CD-4 quadraphonic, \$13.96.

First, Schwann lists RCA's CD-4 quadraphonic at the same price as the alternative stereo, a halfway sort of "single" inventory. Check your dealer. Eventually, we can hope for ONE release, stereo/quadraphonic, to bear out the RCA label saying "compatible stereo/4-channel" on the front of this and all CD-4 RCA releases. That remains the necessary future for the new medium if it is to survive on discs.

Second—this one is GOOD. I do not know whether it is cut via the new Quadulator equipment, which was to have gone into practical use by early this year, but I can say that the playing of this version in CD-4 offered no problems, not even in the loudest parts; the sound—listening as music—was excellent with an ambience that I do feel is unique to the best CD-4; the levels, still a good deal lower than average stereo (and SQ/QS), seemed to me to run a bit higher than similar CD-4 classical in the recent past, high enough to avoid background noise of any noticeable severity. I did not note undue compressions or other overt audio disruptions—expectable in view of CD-4's inherent complexity in the cutting. All in all, I'd say—good progress.

Two discs, yes; but all the other versions require the same and my only reservation was the ungainly break in the long last movement, which just won't go onto a single side.

There are many big versions of this symphony with chorus and solo voices—I can only say that I found it to be the very best of late by Stokowski, one of his "pure" interpretations, minus overt eccentricities. Beneath his often hammy exterior, this ancient conductor has always reserved a virgin pure asceticism of interpretation for the really great works that deserve, as he surely feels, his



humble best; the recent Beethoven *Eroica* was one and this is another. (If the strings slide up a bit now and then, I expect it was overzealousness, to please the old man, and misguided in this music; if there are inaccuracies, we can surely chalk up the lack of enough rehearsal to human frailty—at 94 years.) Like few conductors now alive, Stokowski knows how to maintain the tension and drama of a huge work such as this while at the same time playing it relatively sparely, minus extra heroics. Other versions notwithstanding, this one is definitely worth anybody's study in depth.

Gregorian Chant. Vespers of the Holy Trinity; Benediction of the Blessed Sacrament. Choir of the Monks of Saint-Pierre de Solesmes Abbey, Dom Jean Claire, O.S.B. Dom Claude Gay, organ.

London OS 26431, stereo, \$6.98.

Tape editing has come to the oldest

AUDIO • AUGUST, 1976

extant written-down Western music! And not with the happy results you might hope for.

I hadn't heard the Solesmes monks for quite some time, though this is only the latest in a series from London. The monks have been recording since '78" days, when I first ran into their memorable music—for it was at Solesmes, in the 19th century, that Gregorian chant was restored from a state of "modernized" debasement to its original form, both in the published special notation (the collection adopted officially by the church at the turn of the century) and, even more important, in the manner of performance—once again without anachronistic accompaniment, pure melody for voices. These monks, then, carry on a tradition already a century old, in music that was first brought together in the Seventh century.

The tape editing is unfortunate, if reasonable. Church services in a Catholic monastery are not hurried and especially not at Solesmes, where this music is a life preoccupation. How to boil down a very long service in the original chant for an LP edition? Obviously, reduce it to the essentials, re-

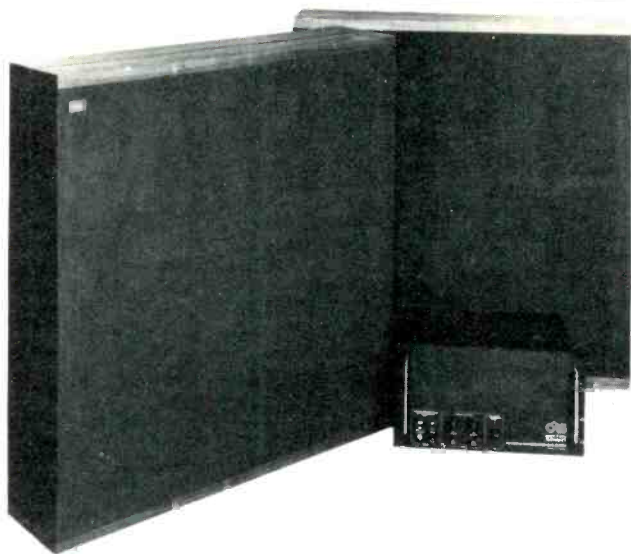
move long pauses, spoken liturgy, combine into one flow the music of different occasions—and, inevitably, edit different "takes" into one piece. It's all in the standard procedure today. In thousands of musical situations this sort of editing is the life blood of the viable LP recording, in spite of strenuous objections from musicians galore. The medium demands it and the technique "works" to perfection, all things considered.

But editing is tricky and a bad edit is worse than a good mistake. Even orchestras play out of tune with themselves; weather does weird things to halls, moods and feelings change unavoidably and will not join together. Bad enough. Much worse things happen in the unaccompanied form of vocal music. There is no fixed mechanical pitch reference; it is all in the mind and the ear. Given the natural sequence of events, in real time, singers who know can do a splendid job of maintaining a viable feeling of pitch and key, unaccompanied. This would be the case at Solesmes, live, even though there are small aberrations in pitch when a forced A-B comparison is made.

That's the rub! Editing is by nature an A-B comparison, of pitches never intended to rub noses, so to speak. As a conductor and recorder of my own (non-Gregorian) unaccompanied singers, I am aware of the dangers in *this* sort of editing. Hair-raising. For as we all know, the closer are two differing pitches, the higher the numerical ratio, the more startling is the dissonance. There is no *almost*. Pitch must be exact, or no edit.

Moreover, Gregorian falls into modes, each a distinct and easily heard scale pattern, clearly set forth as each piece is sung. But a sudden transition from one mode to another is anathema—and *always* avoided in practice. Live, that is.

Alas, London's editors have not had ears for all these things. The music is indeed boiled down and nicely articulated, with normal LP pauses between items and a continuing flow of material in economical form, to fit. BUT (a) there are infinitesimal pitch lapses which are painful in the edited result and (b) musical numbers, which surely were isolated in the living rendition, are put cheek to jowl, wrenching one mode into another, most un-



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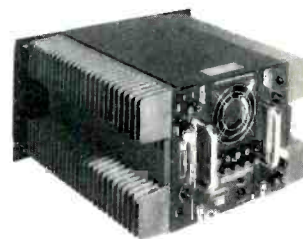
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musically and, clearly, not as the Monks themselves would have had it.

Admittedly, these are subtleties. But pitch, in particular, is a thing easily perceived A-B by untrained as well as trained ears. I think a good many people will find this and other similar Gregorian records distressing.

(Organ? Not to accompany the chant; there is an opening and a closing organ piece, Buxtehude and Couperin, on a very fine Baroque-type organ.)

Lalo: Overture "Le Roi d'Ys"; Symphony in G Minor; Rapsodie. Nat. Opera Orch. of Monte Carlo, Almeida.

Philips 6500 927, stereo, \$7.98.

The biggest service that classical recording has done us has been to round out our knowledge of the middle-range composers, not the best but often far from the worst. In pre-recording days the "standard concert repertory" often featured just one work from many such composers, usually NOT his best—though one could not be too sure of that. Sometimes (say, *The Sorcerer's Apprentice*) it was indeed the very best he had done.

Lalo? The "one" work is the familiar *Symphonie Espagnole*, for violin and orchestra, six recordings of it still new today. So here, on this Philips disc, is a bit of Lalo background. How does he fare?

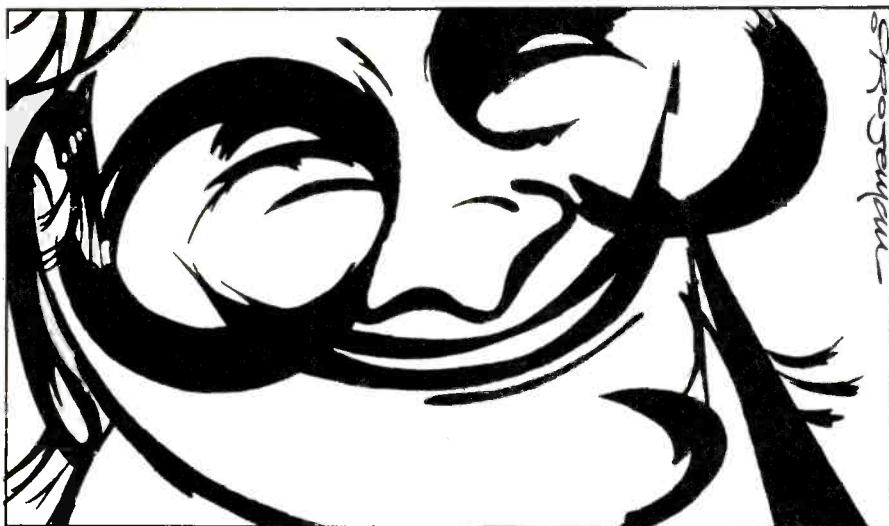
Not well. The music seems unusually dated—an ancient term which in effect means that the artist was more a follower of fashion than a profound thinker on his own. Lalo was, indeed, a good imitator—his "Spanish" music was perhaps his best; here we have a *Rapsodie* that was originally a Norwegian item, also for solo violin, and by golly, it could be Grieg for all we know. The big Symphony is of that unfortunate sort of French music that did its best to emulate Brahms and Schumann, a thing that few French composers should ever have tried. I found it full of obviousness, though with enough beguiling French melody to keep it going.

Funny, Debussy, it says, got tossed out of a concert hall when he objected to the audience's lack of warmth at another Lalo premiere. Well, he was just a kid.



AUDIO • AUGUST, 1976

Jazz & blues



Violinspiration: Stephane Grappelli & the Diz Disley Trio.

Musicians: Grappelli, violin; Disley, Ike Isaacs, guitars; Isla Eckinger, bass.

Songs: *Lover Come Back To Me, Sweet Lorraine, Shine, Solitude, Ain't Misbehavin', Souvenir de Villingen, Hot Lips, My Heart Stood Still, The Nearness of You, Joy, A Nightingale Sang in Berkeley Square, Cherokee, Lover Man.*

BASF MC 22545, stereo, \$6.98.

Among the many current recordings by the great French violinist, this one most closely recalls the peculiar charms of the Quintette du Hot Club de France with which he made his reputation in the 1930s.

There is no Django Reinhardt here, of course, but the two rhythm guitars and the bass, the absence of piano and drums, and a program including several pieces from the old repertory add up to music that is both delightfully nostalgic and fresh.

Grappelli is buoyed by the chugging yet swinging rhythm trio and pretty much has the show to himself, occasional short guitar bits (and a fine bass solo by Eckinger, a distinguished Swiss jazzman, on *Solitude*) notwithstanding. In his late 60s now, Grappelli has never played better. His command of the instrument is unequalled among jazz practitioners, and in a league with the best classicists (as wit-

ness his collaborations with Menuhin). His ear is impeccable, and so is his taste, and there is a joyous feeling to his playing that communicates to all lovers of music.

On *Villingen*, Grappelli accompanies himself on electric piano via overdubbing. It makes for a pleasant change of pace. *Dan Morgenstern*

Sound: A Performance: A

Whatever Happened To Johnny Bothwell?: Johnny Bothwell

Bob Thiele Music BBMI-0741, mono, \$5.95.

Indeed, what did happen to Johnny Bothwell, an excellent jazz musician, and one of the best lead altos in the band business? According to Dan Morgenstern, who did the liner text on this excellent album, Bothwell is working in Florida as an industrial photographer; another fine musical career down the drain because of a shift in popular taste from the band era to the trash pop of the late 40s and early 50s, and finally to the ultimate low, the crude amateurism of early rock.

Bothwell played with Tommy Dorsey, Gene Krupa and Woody Herman, but began to draw attention in jazz circles around 1945-46 when he joined Boyd Raeburn's experimental, progressive jazz band. With Rae-

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burn's men he cut a number of studio sessions for Bob Thiele's Signature label; most of them are included on this LP. Bothwell, like other alto men of the period, was indebted to Ellington's Johnny Hodges for his sound. The sweep and tone of Bothwell's performance here, while undoubtedly drawn from Hodges, has a cutting edge all of its own, and it comes through with tremendous authority on such standards as Harold Arlen's *Ill Wind*, Billy Strayhorn's *Chelsea Bridge*, and Johnny Hodges' *Cover the Waterfront*. The first cho-

uses on each of these exuberant selections are handled ballad style, then the back-up Raeburn band jumps like mad.

The remastering job by Thiele is commendable; the original monaural sound is both crisp and clear.

John Lissner

Sound: A- Performance: A

On The River: The New Black Eagle Jazz Band

Dirty Shame 2002, stereo, \$5.95.

The new Black Eagle Jazz Band is a Boston-based group made up of part-

time musicians, business and professional men who play regular weekend dates at the Sticky Wicket Pub in Hopkinton, Massachusetts. This is not one of these traditionalist bands rehashing *When the Saints Go Marching In ... Just One More Time*. One of the New Black Eagle Jazz Band's strongest points is its interesting repertoire, which it plays with gusto and grit. This collection consists of a mix of Armstrong and Johnny Dodds material and post 1930, pre-1950 Tin Pan Alley pop tunes, all played in the New Orleans style.

Noteworthy is cornetist Tony Pringle's driving lead in the ensembles, Stan Vincent's brash, bristling trombone, and Stan McDonald's superb clarinet and soprano sax on uptempo numbers like *Oriental Man* and *When I Grow Too Old To Dream*. McDonald, incidentally, could hold his own in any top-notch professional band. The New Black Eagle Jazz Band is one of the best revivalist groups around; they bring a bouyant spirit, warmth, and good musicianship to everything they play. The album is well recorded and available only by mail order; write: Dirty Shame Records, Box 5217, Hannegan Station, St. Louis, Missouri, 63139.

John Lissner

Sound: A - Performance: B+

Summer Solstice: Azar Lawrence

Musicians: Lawrence, soprano and tenor sax; Raul De Souza, trombone; Gerald Hayes, flute; Amaury Tristao, acoustic guitar; Dom Salvador, piano; Ron Carter, bass; Albert Dailey, piano; Guilherme Franco, drums, percussion; Billy Hart, drums.

Songs: *From the Point of Love, Novo Ano, From The Point of Light, Summer Solstice, Highway.*

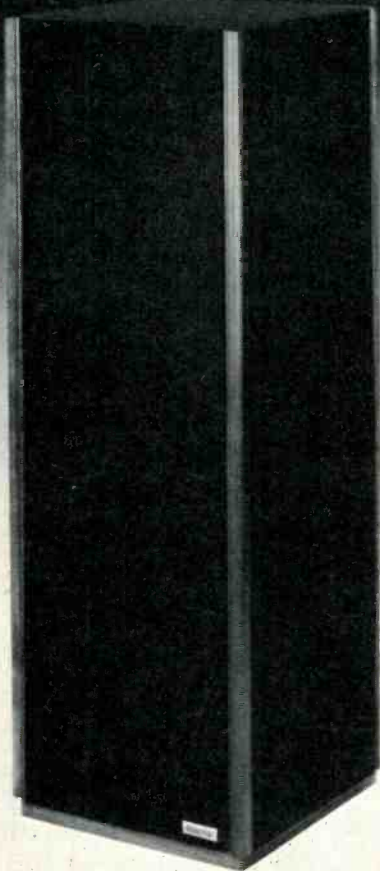
Prestige P-10097, stereo, \$6.98.

Two of the most powerful and increasingly important saxophone voices, Sonny Fortune and Azar Lawrence, have matured and developed individual styles within the musical continuum of McCoy Tyner's groups, just as Tyner's talents began to crystallize within the Coltrane realm. Now these two saxophonists have stepped out on their own, and in their respective solo albums, they successfully reflect the lessons and directions of Tyner and a strong balance of the further avenues they intend to pursue.

Lawrence is Tyner's current red man. On **Summer Solstice** he continues to develop the audibly evident musical concepts of **Bridge Into The New Age** (Prestige P-10086), his first LP. **Bridge**, which included fellow

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group members bassist Joonie Booth and drummer Billy Hart, consequently bore a somewhat greater degree of Tyner influence than this LP. The album remains a solid, truthful testament to Lawrence's musical requisites and abilities. Familiarity and understanding between personnel on **Bridge** may have helped ease Lawrence's transition to leader. The obvious musical successes of **Solstice** make it quite evident that Lawrence, as a sensitive professional, is most adaptable to changes in personnel without the worry of personal frictions. Musical and spiritual rapport abound.

The more intense Brazilian flavor of **Solstice** is traced directly to the increase of Brazilian musicians. *Highway*, a festive samba, features a carnival of Brazilians, including trombonist Raul de Souza, composer Amaury Tristao on acoustic guitar, and pianist Dom Salvador, in a most convincing, melodically swaying piano solo.

Novo Ano, another super samba, is from the same session as *Highway*, obviously. The colorful harmonies of Lawrence's soprano and Tristao's voice are outstanding. Indicative of Wayne Shorter's *Native Dancer*, *Novo* has much more fire and drive and much less subtlety—all functions of the contrasts between Shorter's introverted approach, and Lawrence's extroverted playing and outgoing personality. Guilherme Franco, percussionist and drummer here, contributes his musical share in brushwork ... and I mean Brazilian brushwork, paralleled only by fellow countryman Airtio (with *Return to Forever*).

Point of Light is from the additional taping for this album and features such luminaries as Ron Carter, and Tynesque Al Dailey. What a big sound these guys produce. Al Dailey plays so much piano. Of course, it's the rhythmic and melodic genius of one Ron Carter that supplies the life foundation to this energy laden composition. Carter's role in this most progressive situation is desirably comparable to his role in **Trident** (Milestone 9063, an unequalled trio album in 1975; mixing the talents of Elvin Jones, Tyner, Carter). In both cases he is free of the harness he wears at CTI, where sweet, overproduced commercialized jazz has practically overtaken the firm's adventurous progressive beginnings.

Lawrence knows his axe. He knows harmony, melody and the works. Solid direction and a potent sound crystallize his efforts into a musically and

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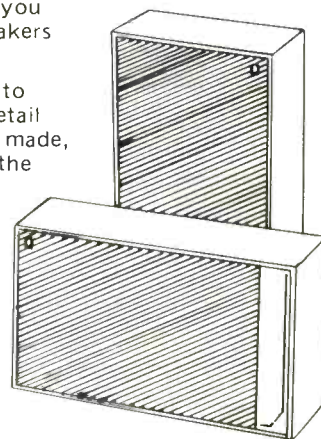
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technically brilliant performance. While he has learned from Trane, his exploration of different ground is revealed, upon closer inspection. If I could pick only a handful of artists to listen to, you can believe Lawrence (*Summer Solstice*) would be one.

Eric Henry

Performance: A Sound: B+

The Tommy Flanagan Tokyo Recital: Tommy Flanagan Pablo 2310-724, stereo, \$6.95.

I understand that, to date, sales of this splendid album stand at a paltry 6,000 copies—so much for the taste level of the mass record consumer. Alas, Tommy Flanagan isn't going to appeal to the shop girls, secretaries, and studs who frequent the discos and buy millions of Elton John, Diana Ross, and Earth, Wind & Fire recordings. Flanagan is also unknown to the "crossover" audience, those quasi-jazz fans who boogie ecstatically to the latest sounds of Herbie Hancock and Chick Corea. It is a handful of buffs that provide the meager support for artists like Tommy Flanagan, and that's why he has submerged himself in his role as ace accompanist to popular singers. In the 60s he worked with Tony Bennett, and for the past six or seven years he has supported Ella Fitzgerald who, these days, needs all the help she can get.

During the periods when Ella isn't working, Flanagan gets a chance to do his own thing (Ella rarely gives him a solo); he works occasional gigs at Bradley's, an excellent piano room in NYC's Greenwich Village, and last year he joined Norman Granz at the Tokyo Jazz Fair where Granz was astute enough to record this superb set of Ellington/Billy Strayhorn tunes.

Flanagan, one of the finest interpreters of Bud Powell's bop piano innovations, is a soloist of impressive rhythmic and melodic gifts; I've never heard him when he doesn't play with taste and a supple flow of invention. On this recording, his keyboard agility is a dazzling display on numbers like *Caravan*, *Mainstem*, and *Take The A Train*, all crisp, precise performances performed with a light, driving swing. Flanagan gets fine support from drummer Bobby Durham and particularly bassist Peter Betts, a powerful accompanist whose brawny style provides excellent little fills when a space opens up. On the Ellington/Strayhorn ballads, the two rhythm men respond beautifully to Flanagan's changes in mood, tempo, and feeling. Their rap-

AUDIO • AUGUST, 1976

port with the pianist is deft and sensitive as Flanagan's gossamer touch turns *Chelsea Bridge*, *Day Dream* and *Something To Live For* into melodic gems.

My only complaint about this album is the sound—it's a bit boxy—I had to turn the treble on my hi fi all the way up to get the clarity and definition I wanted. *John Lissner*

Sound: B Performance: A+

Continuum: The Duke Ellington Orchestra Under Mercer Ellington: Fantasy F-9481, stereo, \$5.95.

When Mercer Ellington took over the helm of his father's band the day after Duke's funeral to honor a commitment in Bermuda, he had, to put it mildly, severe personnel problems. Of course, the "pianist" had to be replaced; indeed, the bodies of two Ellington stalwarts, Duke's tenor man of 20 years, Paul Gonsalves, and Ellington's long-time vibist and trombonist Tyree Glenn were both lying in the same funeral home along with the maestro.

Mercer Ellington still had two of the greatest Ellington veterans, baritonist Harry Carney, the rock on which the band was built for almost 50 years, and trumpeter Cootie Williams. Sadly, Carney was to pass away in the next few months though fortunately not until he recorded two cuts on this album, *Blue Serge* and *Drop Me Off In Harlem*, where his authoritative, robust sound makes its presence felt. Carney's replacement, Joe Temperly, makes a good stab at the baritonist's tone and phrasing on a tribute piece called *Carney*. Mercer Ellington's replacement for his father on piano is one Lloyd Mayers who utilizes the Duke's florid, flowing inflections, spare chordings, and dazzling arpeggios. New tenor sax man Ricky Ford is an admirable addition to the Ellington ranks and does a standout job on *Happy Go Lucky Local*. But overall, since these sides were made in 1974 and early '75, the ensemble sounds tentative; the rhythm section doesn't always kick. I understand that in the past year, the band's performances have greatly improved; if Mercer can hold the group together and the musicians get a bit more adrenalin into their playing, perhaps the spirit and music of Duke Ellington can be preserved. *John Lissner*

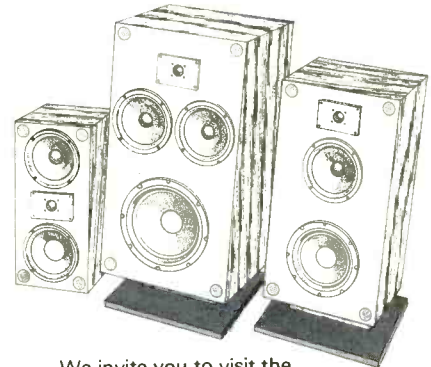
Sound: A — Performance: B

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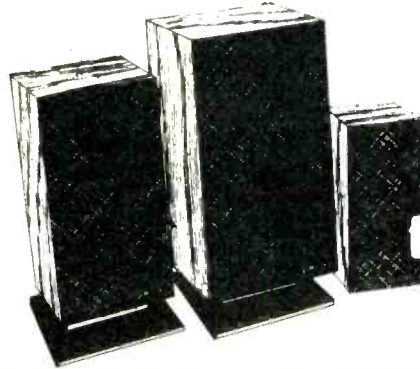
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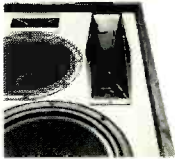
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“It’s one thing to design an acoustic air suspension system that will have low distortion. And it’s another to design a ported system for high efficiency. But here, in one unit, Marantz offers the audiophile the best of both worlds.”

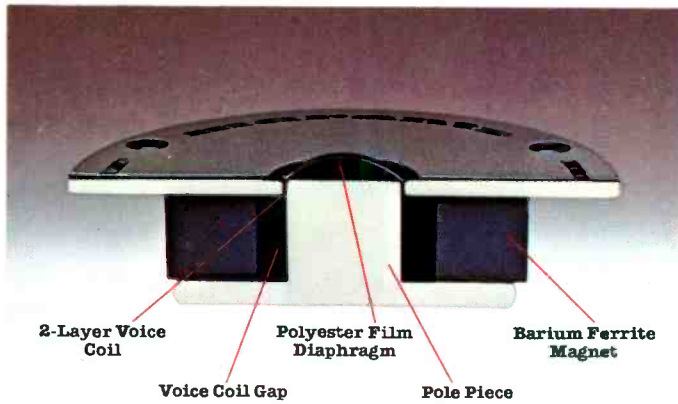
“It’s incredible. Marantz calls it **Vari-Q***. Pull out the high density acoustic foam plug and the system becomes a tuned port reflex. Push it back in and the port is absolutely sealed and the speaker becomes air suspension.”

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HD-88

*Patent Pending. **Manufacturer's suggested list price. Actual selling price at dealer's discretion. (The enclosures for the HD-88, HD-77 and HD-66 are constructed of particle board, finished in genuine walnut veneer. The enclosures for the HD-55 and HD-44 are finished in walnut grain vinyl.)



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