

The
Authoritative
Magazine
About
High Fidelity

Audio

AUDIO ETC:
CLASSICAL
RECORDING

AUGUST 1980 • \$1.50 • F 06030

PROFILE:
Paul Klipsch-
Arkansas
Speaker Maker

Alternative
Speaker
Technologies



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WITH ONLY ONE EXCEPTION, THIS IS THE MOST REMARKABLE TAPE DECK IN THE WORLD.



**WITH ONLY ONE EXCEPTION,
THIS IS THE MOST REMARKABLE
TAPE DECK IN THE WORLD.**



But without exception it's the most remarkable cassette deck.

Today, a thousand dollars or more is standard fare for a professional quality cassette deck. But when Pioneer designed the new CT-F1250, they not only raised the performance standards of high quality decks, they also lowered the standard price.

Metal tape capability is something most new high quality cassette decks have in common. But while many of them have just been modified for this advancement, the Pioneer CT-F1250 has been specially designed for it.

Instead of the two heads found in most metal capable tape decks, the CT-F1250 has three. And it's these three heads that keep us way ahead of the competition.

Our new "small window" erase head makes a big difference in making sure all metal tapes are wiped completely clean. And our Uni-Crystal Ferrite recording and playback heads give you greater frequency response and better wear-resistance than the ordinary ferrite and Sendust alloy heads you'll find on most other tape decks.

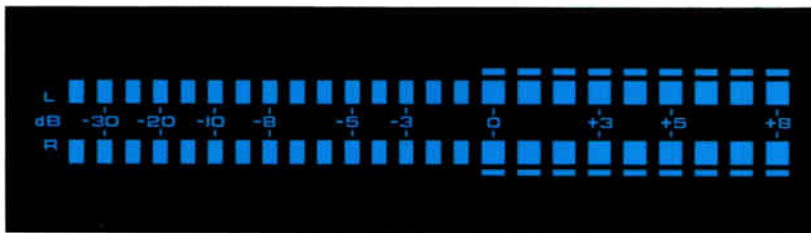
But you don't get distortion-free recordings just by using your heads.

Instead of the single capstan tape transport system you'll find on some tape decks that are nearly twice the price, the CT-F1250 has a closed-loop dual capstan system, similar to that found in our remarkable RT-909 open-reel deck. This system



Metal tape capability for far greater dynamic range and far less distortion.

Pioneer's 24-Segment Fluroscan Meter gives you an instantaneous picture of what you're listening to.



keeps the tape in perfect contact with the heads at all times. So you are assured of getting everything that's on

the tape. Nothing more; nothing less. What's more, the CT-F1250 has a Quartz-Locked Direct Drive capstan motor that senses the slightest deviation in speed and automatically corrects it to keep wow and flutter down to an unbelievable 0.03%.

It's engineering innovations like these that make the CT-F1250 so remarkable. But equally remarkable are the features that make the CT-F1250 so easy to operate.

Like our specially engineered Tape Calibration System that lets you quickly set bias level, Dolby adjustment, and record equalization for the best possible signal-to-noise ratio, the lowest distortion, and the best high frequency response.

And our 24 segment Fluroscan meter that works on Pioneer's own microprocessor to give you a more accurate reading of what you're listening to. It even has

Peak, Peak Hold, and Average Buttons that let you record without fear of overload.

In addition Pioneer's CT-F1250 has a digital brain with a memory that controls four different memory functions. Plus pitch control. Mic/line mixing. Independent left/right input/output controls. And more.

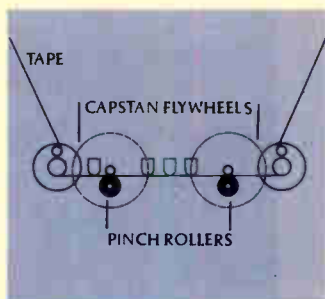
By now, it must be obvious that the CT-F1250 was designed to push up the limits of cassette deck performance. But only Pioneer would do it, without pushing up cassette deck prices.

PIONEER®
We bring it back alive.

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Pioneer's easy-to-use Tape Calibration System guarantees optimum performance from every tape.



Pioneer's Closed-Loop Dual Capstan Tape Transport System ensures constant tape-to-head contact.

But without exception it's the most remarkable reel-to-reel.

Today, many audio manufacturers are putting a lot less into their tape decks and charging a lot more for them. But when Pioneer designed their new RT-909 open-reel tape deck they made certain it had every conceivable feature an audiophile could expect.

And one feature that was totally unexpected. A reasonable price.

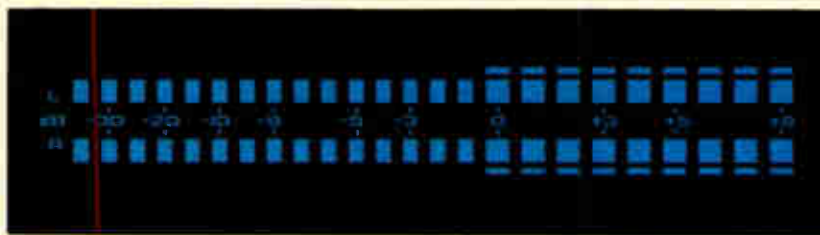
Even if you pay \$1500 or more for a so called "professional" quality tape deck, you'll probably still be getting a conventional single capstan tape transport system that is prone to wow and flutter.

Pioneer's RT-909 has a specially designed closed-loop dual capstan system that isolates the tape at the heads from any external interference. So you get constant tape-to-head contact. And constant, clear, accurate sound.

And while many of the expensive new tape decks have old fashioned drive systems that drive up heat and distortion, the RT-909 doesn't. Instead, it has a far more accurate DC motor that generates its own frequency to correct any variations in tape speed. And keeps wow and flutter down to an unheard of 0.04% at 7½ ips.

What's more, the drive system of the RT-909 is unaffected by fluctuations in voltage. So a drop in voltage doesn't mean a drop in performance. The RT-909 also has a logic system that ensures smooth, accurate speed change.

Most professional quality tape decks are designed for use outside the home. So the convenience features



Pioneer's 24-Segment Fluroscan Meter gives you an instantaneous picture of what you're listening to.

most audiophiles enjoy are nowhere to be found. The RT-909, on the other hand, offers automatic reverse, automatic repeat, and a timer controllable mechanism that lets you record a midnight concert even if you can't stay awake for it.

Examine our heads and you'll see Pioneer engineers at their very best. Our playback heads, for example, have a new "contourless" design that makes them more sensitive. They increase frequency response upwards to 28,000 hertz, and extend it all the way down to 20 hertz. So you not only get greater range than any other tape deck, but also any other musical instrument.

Of course, these features alone would make Pioneer's RT-909 quite a remarkable tape deck.

But the RT-909 also has a Fluroscan metering system that gives you an instantaneous picture of what you're listening to. A pitch control that lets you listen to music in perfect pitch even if it was far from perfectly recorded. Four different bias/equalization selections so you can use many tapes and get maximum performance from them all.

Obviously these advancements are very impressive. But there's still one thing even more remarkable than the technology we feature. It's the price we feature.

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Independent bias and equalization for maximum performance from any tape.

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World Radio History

Audio

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About the Cover: To find out more about the dawning of new speaker technologies, see Gary Stock's article beginning on page 32. Photograph by Richie Williamson and Dean Janoff of Aerographics; Obelisk loudspeaker courtesy of Shahinian Acoustics Ltd.

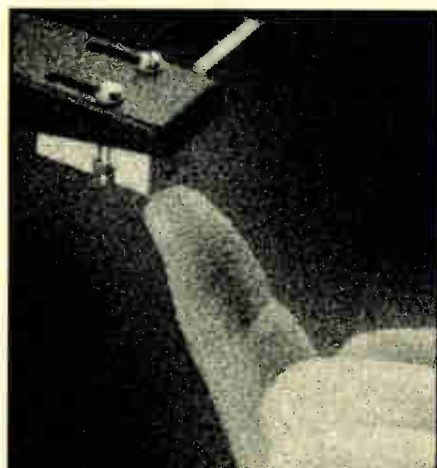


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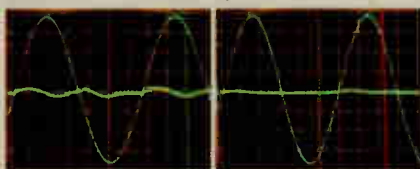
Only JVC combines Super-A purity and graphic equalization in a receiver.



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Class-AB Jagged center line indicates switching distortion.

JVC Super-A Minimal distortion in output waveform.

At the same time, you'll get plenty of power. The R-S33 shown here gives you *40 watts per channel minimum RMS into 8 ohms, from 20-20,000 Hz, with no more than 0.007% total harmonic distortion*. A regular Class-A amplifier with this kind of power would be heavy and expensive. But because it doesn't require high idling currents, the R-S33 costs and weighs about the same as a conventional receiver.

Even the most sophisticated amplifier can't correct cartridge peaks, speaker roll-off or room acoustics. Neither can it accommodate your changing tastes in sound as you take off Beethoven and put on disco. That's where JVC's 5-band SEA graphic equalizer comes in. With independent controls at 40 Hz, 250 Hz, 1 kHz, 5 kHz

and 15 kHz, it lets you extend the deep bass without creating boominess. Mellow out a voice without cutting the highs. Add brightness to the extreme highs and more.

With all this, the R-S33 has plenty of other features to recommend it: direct-coupling, a sensitive tuner section with linear-phase IF filters, two tape monitors with equalizer and dubbing facilities, LED power meters, and JVC's triple power protection system.

So if you're interested in getting more without paying more, call 800-221-7502 toll free for the location of your nearest JVC dealer (in N.Y. State 212-476-8300). Once you've heard the R-S33, you'll have no doubts about which receiver gives you the most for your money.

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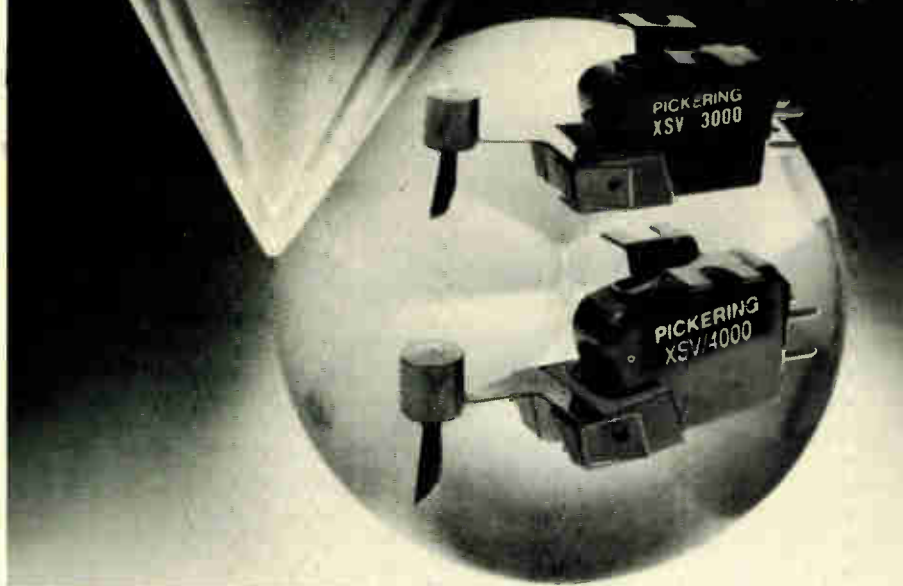
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Discwasher D3® solution (left) beads up on the grooves. Sound Life (right) with super-wetting action deep-cleans grooves.

If your present cleaning solution beads up on the record surface, it may not be getting the job done.

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As it cleans, it wipes out static.

Even though your record surface is clean, it's generally the electrostatic charge that gets it dirty again. An anti-static gun is just a temporary treatment.

One application of Sound Life reduces the residual charge to near zero. And it prevents static from returning no matter how often the record is played.



(Left) Styrofoam beads are attracted to static charge left on record after cleaning with Discwasher D3®.

Same record (right) after one treatment with new Sound Life fluid.

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3M

Audioclinic

Joseph Giovanelli

Distortion Problem

Q. I am a professional entertainer with a six-piece musical group in which everyone either solos or sings together in ensemble. I use six microphones wired for high impedance and a six-channel, 30-watt amplifier. When the individual mike levels are adjusted to a volume such as to make each singer heard as a soloist, the result of the ensemble singing is overload and distortion. Singing less loudly produces a sound lacking in vitality. Backing off from the microphones results in noticeable loss in presence. What can I do? — Name withheld.

A. There could be several things which may account for the distortion you have mentioned. Perhaps the result of all vocalists performing simultaneously results in driving the amplifier beyond its power output limits. It also may be that some of the stages ahead of any master volume control may be overloaded.

Assuming that you do have a master volume control, turn it up, and reduce the settings of the six individual mixing pots. This will help unless the mike preamplifiers ahead of the individual mixing pots are overloaded. In that event, you will need a pad between the mike and its associated amplifier input.

A similar result might be obtained merely by wiring the mikes for low-impedance operation. Don't worry about impedance mismatching. All that would happen is that the microphone would produce less output. There might be just a bit more noise from the electronics of the amplifier, but this would be overridden by the desired program.

Calculating the Wave Length Of Sound

Q. I know that for electromagnetic waves, wave length equals the velocity of propagation through the particular medium, divided by frequency. For example, at 1 MHz the wave length is:
 $x = (300 \times 10^6 \text{ meters per sec}) \div (1 \times 10^6 \text{ Hz}) = 300 \text{ meters.}$

Is there a formula for finding the length of an audio frequency wave?

— Name withheld.

A. The method for determining the wave length of any frequency is the same as you use for determining the

wave length of a 1-MHz signal. Sound waves traveling through air move at approximately 1,100 feet per second. (This speed does vary somewhat with temperature, but this figure gives a good approximation.) By substituting this figure for the 300,000,000 meters per second, you will arrive at the wave length of a given frequency. Note that a signal having a 1,100-Hz vibration rate will have a wave length equal to one foot. A frequency of 550 Hz will have a wave length of about two feet.

Standards for Stereo Placement

Q. Are there specific standards followed by engineers during recording? I have noticed that on most recordings, a vocal is always centered but a guitar and/or organ will be recorded at left or right. Other instruments in the sound field are not easily localized. Is there a universal coding system that most engineers follow? — Bob Hoffman, Worth, Ill.

A. There are no specific standards for assigning instruments to a specific channel, at least with "popular" music. It is true that the vocal is almost always centered and that the bass is always centered. The vocal is centered in an attempt to produce a compatibility between the stereo sound and the sound which would be heard if the recording were played on a mono system, such as over an AM broadcast station. The bass is centered because of the nature of the disc-cutting process. When centered, the bass produces only lateral modulation of the groove. Because the bass displaces the groove more than anything else, it is better not to have any vertical groove displacement. Under some conditions, where the bass is not centered, such displacement might be so great that the cutting stylus would actually lift from the surface of the disc for an instant, causing a break in the grooves.

The remainder of the instruments and the background vocal placement is left to the judgment of the artist, the producer, and the recording engineer. Much of the success of a recording may depend on this placement and upon the superimposition of special effects, such as phasing and reverberation, which are often needed.

In classical music, the engineers usually try to reproduce the sound of the musicians just as they are seated

when making the recording. Bass centering is automatic, however, and in some instances there may be added reverberation or equalization.

Impulse Noise Reduction


Q. I am considering the purchase of a transient noise filter and plan to use it for general playback of discs as well as for recording from discs onto tape. The discs I record from are often in less than optimum condition. From what I understand of these filter devices, they are noncomplementary and work by eliminating noise by means of an "attack time" principle. This being the case, can such a device be used to cut down on noise from any program source — i.e., FM or tapes already recorded from scratched records? Is such a device effective only when filtering scratches, ticks, etc. from discs? — Kenneth Lisagar, Bayside, N.Y.

A. The noncomplementary devices designed to cut down on impulse noise will "look for" peak rise times. (That should be steep rise times.) Even a cymbal crash does not have the fast rise time of a scratch on a disc.

The device does not "know" what is feeding into it. All that it does know is that it must act upon "seeing" steep rises of energy, whether they come from the output of an FM tuner or from that of a tape which contains this impulse noise.

Bandwidth and FM Tuners

Q. Please explain why and how bandwidth is related to frequency response in FM reception. — R. Zimmerli, Muttentz, Switzerland

A. The bandwidth of an FM tuner has little effect on frequency response. Bandwidth does, however, play a vital role in distortion and stereo separation. If the bandwidth is restricted, the extreme ends of each modulation cycle will be depressed or completely removed. This will produce IM and harmonic distortion. In addition, sidebands may be reduced, with the result that some of the stereo information may be lost, leading to a decrease in separation. 

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.

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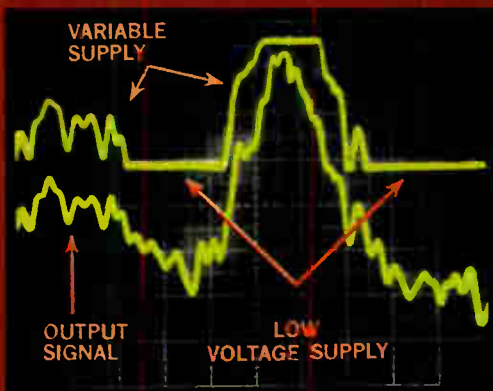
The new Amp uses 1/2 inch PHONE JACK INPUTS for BALANCED or UNBALANCED operation in EITHER the STEREO or BRIDGED MONO mode. Outputs are 5-way binding post (banana plug) type. Front panel includes a SEPARATE LEVEL CONTROL for each channel as well as fast-attack LED CLIPPING INDICATORS and a DELAY TURN-ON power switch. The 1/2 inch aluminum front panel is 13 inch rack mountable, and the massive handles are bolted through the front panel into the 16-gauge steel main-frame. An individually serialized Lab-measured TEST DATA CERTIFICATE is provided with each unit showing LAB MEASUREMENTS of that unit and signed by the Final Inspector. Size is 7 in. x 19 in. x 15 in. deep, weight is 55 lbs.



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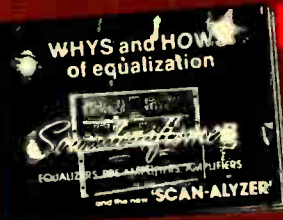
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World Radio History

Audio etc.

Edward Tatnall Canby

What is the future of classical recording? Silly question: Nobody knows and everybody guesses. Which gives me a Prognosticator's License that is just as good as yours. So here goes — but first, some background. We need what my father called a Frame of Reference. A surround. You can say two things about classical music (how I hate that term — but it will have to do for the moment).

First, the totality of music that rates as "classical" — a bewilderingly vast area of sonics extending in place the world over and in time a thousand years, is a very small part of our American sales scene. We all know it. There is that fabled "only four percent of the market" figure, though I expect that eight percent might be a better average over recent decades. Even at 10 percent, this would not rate as a very important dollar factor. So why bother? Why do we keep right on recording classical music, and importing classical music, in all its million-odd varieties?

Second comes an answer to that question in our terms, hi-fi, because classical, on the whole, is vastly more important to recording than the mere dollar sales can ever suggest. That's why. Classical music is the industry's R & D area, you may believe. It is also the industry's prestige factor, as every record company knows. Furthermore, classical of one sort or another is the hi-fi man's testing ground; he is always "testing" — i.e., acquiring seductive new equipment. If, during depressions/recessions, hi-fi is to exist at all as a business, then classical music must go along with it.

Not that pop music (in all its forms) is useless for us — let's not go to extremes. Most fancy demo discs, you

will note, offer a combination, often one side classical and the other pop, one sort or another. Or if two discs or two tapes, then one is classical and one is pop. This, of course, is already far from the marketable proportion: 50/50, and thus a large compliment to the importance of classical. Pop music does rate very well in hi-fi circles but it has curious disadvantages as a hi-fi medium — indeed, contradictions that

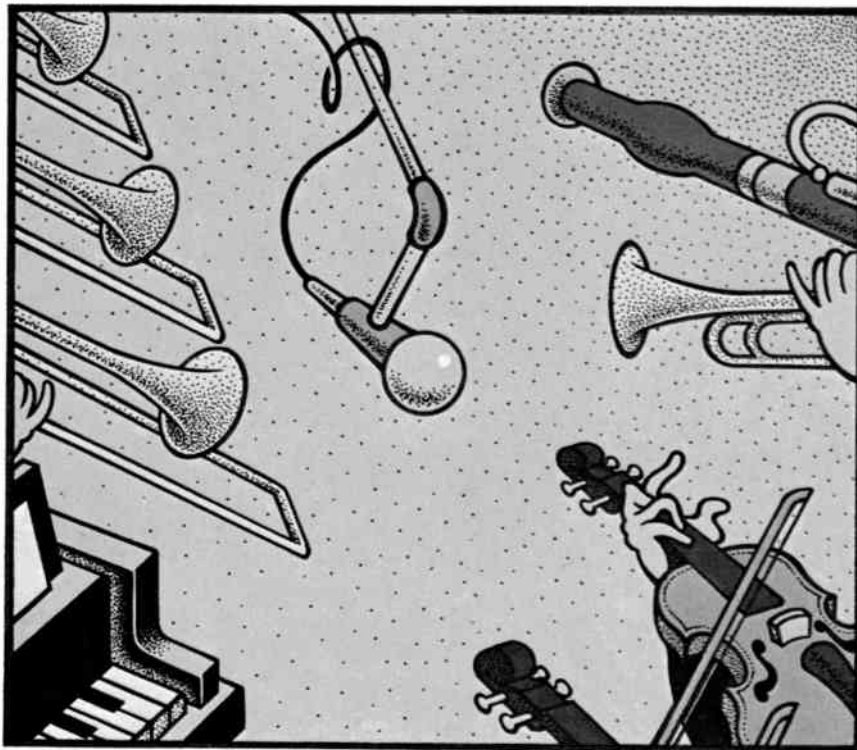
BUT — do these fabulous techniques further the cause of good fi? Hardly. Yet they continue to grow ever fancier and ever more essential to the very life of pop (still using that term as a general one). Can we ever avoid them — for better fi — and still have the music itself as it should be? The magazine *db* has recently been pointing out that there still is no end to the number of available ins (on those

huge boards) and outs (on the recorders) that recording engineers think are necessary to get down their basic audio material. Forty-eight tracks? Many of us, out on the periphery, would think that an absurdity. Not those who are directly involved, within the pop industry.

True, the quality of copied audio in the various generations is slightly (!) improved since Sgt. Pepper. You can now do your analog mixing almost to your heart's content and come out with, well, an acceptable minimum in terms of audible distortion. We do remarkably well. Astonishingly well. And

when digital really gets around and into most studio equipment (it's on the way), added distortions via mix-down will be strictly incidental, mere side effects not directly measurable as the result of copying. You can copy *ad infinitum* in digital. But does this mean we are in the clear as to *optimum hi-fi*? Oh no, not by any means.

I must be careful to keep within my own non-engineer bounds but I do sense, via all sorts of engineering comment and many a paper in the mags, at AES and so on, that there are insidious and even drastic problems in the mixing of many mikes and/or many tracks quite aside from the degradation that comes with (analog) copying. Especially in the use of many simul-

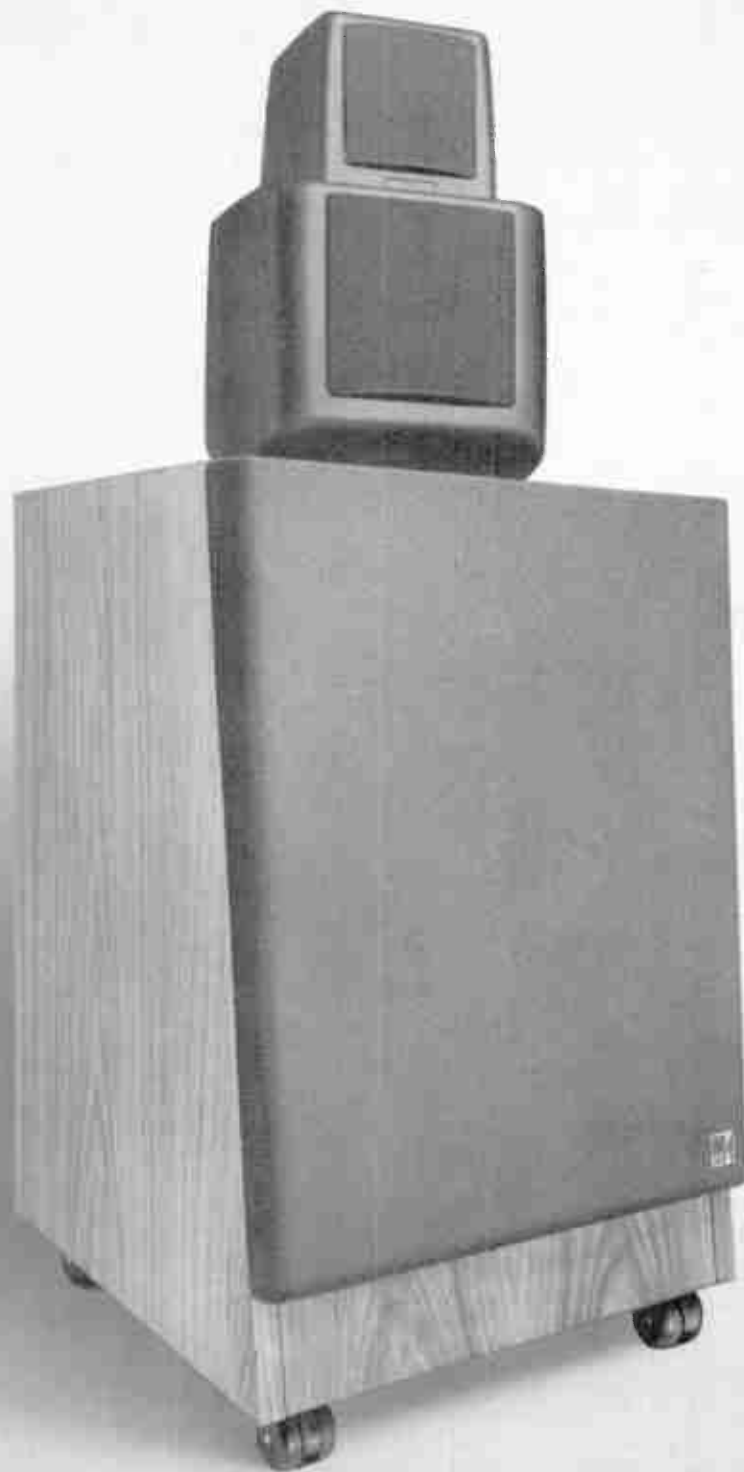


make one wonder. Classical is easier.

In a positively negative way, virtually all "regular" pop music, i.e. that which is recorded for solid commercial distribution, is done via the immensely advantageous mixdown technique, not in real time. Tracks, groups of tracks, recorded at different times (and places), erased, selectively recorded again and again, mixed down to one or more "final" versions — possibly quite different. (And more can be made in future updatings). Marvelous flexibility! Terrific usefulness in a competitive market. Vast resources for otherwise technically impossible sound effects, including duets and trios and choruses built from one voice . . . all of which is familiar to us.

Illustration: Leo Pando

KEF Reference Model 105 Series II: Unique Protection, Extraordinary Performance



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PEAK: The peak protection mode causes the S-STOP circuit to operate whenever peak voltages to the system are so high as to be damaging to the dividing network, or likely to cause unacceptable distortion levels on program peaks.

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taneous mikes, which is the *sine qua non* of many tracks. Simultaneous, that is, by the time they are put together in the final audio product. Most conscientious audio engineers are against multi-miking, whether for pop — where it is necessary — or for classical — where it really isn't, but often has been used. If you want real fi, you keep things SIMPLE. Yes?

This trend of thinking is inescapable. Everywhere in high audio circles one reads of the simple approach as technically the best, and not only for miking, either. What, after all, led to the direct-to-disc movement? More than a desire for fewer tape tracks — a preference for NO tracks at all. Now would there be any point, I ask, in feeding, say, 48 microphones directly to a disc lathe, even with the finest of state-of-the-art (digital?) mixing, direct-coupled, no transformers, etc., etc.? If I am right, you try that and you'll still have 99 percent of the technical problems you had before, including all the more subtle ones involving phasings, cancellations, proximities and heaven alone knows what else!

So in the developing pop scene we see an ever increasing conflict between the musical needs of the performance in recording terms — many mikes, many tracks, many overlays and erasures and more overlays — and the strict requirements for state-of-the-art sound quality. This is not unlike the problem of the pop "live" performance, which must compete in the flesh with the mixdown recorded versions of the very same music, often with embarrassing results. How can a band playing before an audience stand up to its own reputation gained via recordings? Ask the bands — they have to sweat this one out.

Ah yes, you may say, but we have to take into account the fabled spontaneity of the live situation, the excitement of real, honest-to-God listeners right out there in front of you. Classical musicians put this aspect very much first and never tire of talking about it in relation to recording. For sure! The live element of spontaneity is exactly the same for pop as for classical — and maybe more, what with so many screaming thousands out there reacting. But —

Relatively Listening

Look at classical again. The stuff (still using the general term . . .) marvelously lends itself to *simple* microphone techniques, though it can be done in the more complex modes and often has been. I personally have enjoyed the musical impact of multi-mike classical recording, even if the overlay technique, not in real time, is

rare, almost non-existent. I have not found the increased distortions very much of an impediment to good listening — if and when the results are musically interesting. It's a matter of relative values, and each of us must decide in terms of our own enjoyment. Nevertheless, it is clear that most classical music, of all kinds, does record gracefully via the simplest and most direct means, the very sort that produce the highest fi. If not better than fancy multi-mixdowns, the classical results of simplicity in the recording are most certainly just as good. Can you say that of pop?

Classical music, of course, was intended for live performance and its sonics were designed directly for that purpose; so why shouldn't it sound best in live performance? Even in live broadcasting its sound comes over well, if not ideally from the point of view of your home loudspeaker. The spontaneity, complete with real applause (not faked), is always there and most of the musical sense too. Even our studio or concert-hall recordings of classical are invariably in real time, though edited, all of the performers playing together; only once in a blue-green moon is there an overlay, and that usually is a drastic rescue device to correct some hideous slip where there is no alternative take.

Classical procedures are *inherently simple*, if subtle. Pop recording is *inherently complex*. Classical thrives on basic, clean recording techniques; pop, most of it, suffers from the same and oddly enough must adapt, that is to say, become *more like classical* in order to produce the required fi.

Now all this is merely one technological approach to the matter of classical music's extraordinary importance in hi-fi, sales or no. Look at another sort of basic difference — in the very definitions of classical and pop.

Classical music as a whole, in all its million forms, can be compared to the millions of books in a large public or university library. The essence of both is *variety*, to a perfectly enormous degree. Classical music is by definition music from all sorts of times and places and eras, even including a bit of our own. Pop music, in contrast, is by definition the music of one time, one purpose, one era — our own. It is NOW music, with maybe a bit of yesterday, the nostalgia and the golden oldies. Not very yesterday, even so, and not really much like yesterday in sound, at that. Pop's biggest asset is decidedly not variety, or shall I say, micro-variety, even within its many facets. It must always pursue sameness, with the most carefully minimized micro-variety of innovation within the

Empire's EDR.9 The Phono Cartridge Designed for Today's Audiophile Recordings



Direct-to-Disc and digital recording have added a fantastic new dimension to the listening experience. Greater dynamic range, detail, stereo imaging, lower distortion and increased signal-to-noise ratio are just a few of the phrases used to describe the advantages of these new technologies.

In order to capture all the benefits of these recordings, you should have a phono cartridge specifically designed to reproduce every bit of information with utmost precision and clarity and the least amount of record wear.

The Empire EDR.9 is that cartridge. Although just recently introduced, it is already being hailed as a breakthrough by audiophiles, not only in the U.S., but in such foreign markets as Japan, Germany, England, France, Switzerland and Sweden.

What makes the EDR.9 different?

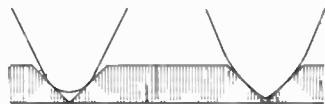
1. _____



Within the cantilever tube, we added a mechanical equalizer. It serves two purposes: (1) to cancel the natural resonance of the cantilever tube, and (2) to

improve the overall transient response of the cartridge. The end result is a stylus assembly that has a mechanically flat frequency response. The frequency response extends from the 20Hz to 35Hz with a deviation of no more than ± 1.75 dB. No other magnetic cartridge has that kind of performance. We call this stylus assembly an "Inertially Damped Tuned Stylus," the refinement of which took over 6 years.

2. _____



Contact area of ordinary Elliptical Diamond. Large contact area of LAC Diamond.

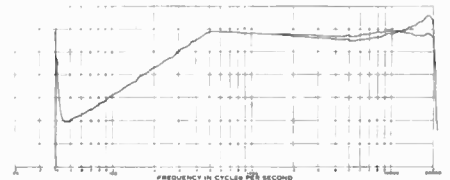
In order to reproduce a groove containing extreme high frequency musical overtones, the stylus tip must have small enough dimensions to fit within the high frequency portion of the groove. Yet, the smaller the stylus tip, the greater the pressure applied to the record surface and the more severe the record wear. In the EDR.9, we have responded to these conflicting requirements by developing a stylus that has the proper dimensions from side-to-side, a much

smaller dimension from front-to-back, and a very large, low pressure degree of contact between stylus and groove top-to-bottom. The net result of this large contact area, which engineers call a "footprint," is that the stylus of the EDR.9 can track musical signals to the limits of audibility and beyond, yet has the lowest record wear of any cartridge presently available. The stylus shape of the EDR.9 is called L.A.C. for "Large Area of Contact."

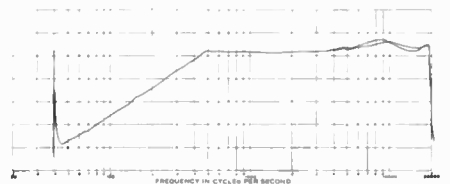
3. _____

Conventional cartridges exhibit radical changes in their frequency response when connected to different preamplifiers. This is because the load conditions—the amounts of capacitance and resistance provided by the preamp—vary tremendously from one preamp to another, and from turntable to turntable. Consequently, most phono cartridges, even expensive ones, have their frequency response determined essentially by chance, depending on the system they are connected to.

But the electrical elements of the EDR.9 have been designed to remain unaffected by any normal variations in load capacitance or resistance. Thus, the EDR.9 maintains its smooth frequency response and accurate transient-reproduction ability in any music system, irrespective of loading conditions.



A conventional cartridge's frequency response changes when connected to different preamps.



EDR.9 is not affected by changes in loading conditions.

4. _____

Then, as a final test of performance, we listen to every EDR.9 to make certain it sounds as good as it tests. At \$200, the EDR.9 is expensive, but then again, so are your records.

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current styles — and no matter that each change is blown up to vast significance! That is a healthy part of the game.

For the expert ear, these micro-changes are indeed sensational and important, always. You wouldn't know it, but I was just then thinking of the court music of Louis XV of France, which though composed for a much tinier and more restricted population than our huge, sprawling audience of millions, still went along by the same rules as our own pop. Strict, almost rigid styles and, within them, minute micro-differences that were endlessly relished by the avid fans as each new performance took place or new printed collection was released from the presses.

Thus we spend vast energy dashing after the latest pop craze or style, converting ourselves hastily from rock to punk to New Wave and on to neo-rock (completing a circle?) as if these phenomena were each enormously different from all the others. In the same way, we dash from one Broadway musical hit to the next, ever more sensationally new, and we are amazed when outsiders tell us they really are remarkably the same, year after year, even to the stock voices and stock characters. Whenever I hear another of those squawk-box sopranos with the flat tones and earthy diction, I say here we go again, it must be the latest. But put a musical comedy beside an opera by Handel, or even Johann Strauss — pop music decidedly in their respective times — and the differences suddenly become MACRO. A whole different order of magnitude, no matter who is listening.

Pop, then, is necessarily monotonous from a purely physical viewpoint. It is all "the same" — that is, of our times. Like the sameness we see and so much enjoy in old movies of the '30s — they reek of *their* time, far more than anybody could have then imag-


ined. Pop is fashion, as with human decor. Those sweeping long skirts of 1937 or so, the flat-sided hairdos of the girls of 1940, the perky round little cloche hats so typical of the late 1920s. I was there — I didn't even notice them. Who would? What we noticed, as always, was the micro-variation, from hat to hat, skirt to skirt, hairdo to hairdo. We were totally unaware of the overall. We always are. It's natural. It's healthy. But in pop music it doesn't make for good fi.

Macro vs. Micro

Finally, since I am beginning to get into more vaporous questions, think of one more curious aspect of the classical importance in audio. It is the combination of MACRO variety, precisely the opposite from the above — variety out of a hundred DIFFERENT times and places, a thousand of them — and the sheer challenge that this variety offers, for recording as well as for the testing hi-fi listener. No more monotony! You can always jump a century or two if you get bored. And the oddest part of it is that the very inadaptability for recording of so much classical music is precisely the positive aspect we find most stimulating. Pop music is too easy. We want the impossible, even if it takes a little longer. Like the cannons in the *1812 Overture*. Will we ever tire of them?

The day that some recording engineer records those cannons as *written*, as "composed," in real time simultaneously with the sound of the huge orchestra, I will run out and order the record in duplicate. I'll need two copies, after all. Now is that a challenge?

Classical music is full of a vast number of challenges, which test and try the parameters of recording, even as we continue to expand them and polish them. By contrast, the main "challenge" of pop music of most sorts is merely, for hi-fi recording, how can we get along without mixdowns? We can't, we really can't. Not for real pop. Not for most pop. I'll take my hi-fi classical any day, thanks.

P.S. Jazz? Oh, didn't you know? Jazz isn't pop, or won't be much longer. These days it rates as classical and gets taught by university professors and studied by musical archaeologists from the original (recorded) artifacts. Also Gershwin and Kurt Weill, Irving Berlin and Cole Porter — they're getting too old for nostalgia. Some day our present pop will also be classical — what then? Maybe the Collegium Whom (a minor misunderstanding of the original title, The Who), newly recorded with classical purity via a single laser mike. Who knows? Could be. 

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Tape guide

Herman Burstein

Unequal Gain

Q. The left channel of my cassette deck records louder than the right channel, both on phono and FM. I would appreciate your help.—Dale Holiday, Willard, Ohio.

A. It appears that either (1) recording gain is higher in the left channel, or (2) playback gain is higher in this channel. You can tell which is the case by playing a tape that has been recorded on another deck (such as a prerecorded tape or one made on a friend's deck). If the problem remains, it is playback gain which is at fault.

Some decks have internal controls for adjusting record gain and playback gain so as to balance the channels. If your deck does have these controls, it is a simple matter for a technician to make the necessary adjustment. If there are no such internal controls, it is still relatively easy for a competent technician to replace an appropriate resistor in order to balance the gain.

If the adjustment has to be made in the record amplifier, one must be careful that record gain is adjusted so as to result in an appropriate indication by the record level indicator. For example, if the deck has a true VU meter, record gain is adjusted so that the meter reads about 0 VU at a recording level that results in about one-percent harmonic distortion for a signal in the range of 333 to 1,000 Hz.

EQ and Bias Settings

Q. I own a large number of rerecorded reel tapes, many from the '60s. They still sound excellent, and most are in good physical shape. I would like to use some of them for recording but am at a loss as to what recording bias and recording equalization to use. Can you come up with a rule of thumb as to what is best to use? — Helmut Kranz, Philadelphia, Pa.

A. Probably the lowest bias setting and the highest record equalization setting of your deck will give best results in recording these old tapes. However, the best test is by ear: Record a tape of a phono disc, play the tape and disc in synchronization, and compare the two. The best settings of bias and equalization are those which, to the ear, give flattest response. If you find that more than one bias setting

gives satisfactorily flat response to your ear, use the highest of these bias settings, thus assuring lowest distortion. Similarly, if more than one record equalization setting gives satisfactory results, use the setting which produces least treble boost.

Excessive Bias Current

Q. I have a nagging problem with my cassette deck: Ferric oxide tape sounds brighter than chrome tape does! My audio dealer said chrome tape should sound brighter and told me to bring in my deck. The bias was slightly adjusted and I was told my heads were almost ready for replacement, but there was no improvement. I brought my deck in again. The bias was adjusted once more, and the dealer said it sounded fine. He also suggested that I try recording at a higher level. The higher recording level did not help, and the second bias adjustment not only failed to improve chrome performance but made ferric oxide performance worse. Is it normal to have to use treble boost with chrome tape, but not with ferric oxide tape? — Dennis Galletta, Erie, Pa.

A. No, it isn't normal to have to increase treble when using chrome tape. It appears that your tape deck is supplying excessive bias when the bias switch is in the chrome position. Apparently, since the dealer's second bias adjustment, your deck is also supplying excessive bias in the ferric oxide position. Too much bias current causes treble loss. I suggest that you look around for another place to have your deck serviced—one with a good reputation. Before taking your deck home again, ask for a bench check; that is, have the shop demonstrate how well your deck is working with both kinds of tape.

Cassette Alignment

Q. I notice that when inserted into my deck, the cassette sits at an angle of about three degrees rather than parallel with the face of the deck. Does this affect the pinch roller and tape heads in any way, or the sound for that matter? — Tracy Ching, Sacramento, Calif.

A. Even though the cassette is not parallel with the face of the deck,

what counts is whether it is in proper position with respect to the transport mechanism. Usually these mechanisms are engineered so that they will not operate unless the cassette is in correct alignment. Therefore, it is likely that matters are all right.

However, you should visit your local audio dealer to see whether other units of the same model have a similar offset. If they don't, then it might be a good idea to have your deck checked out by an authorized service representative. Incorrect alignment will affect high-frequency output, and even the way the tape pack sits in the cassette shell has an effect here.


CrO₂ Abrasivity

Q. Will I damage the heads in a tape machine if I use chromium-dioxide tape?—Richard Bailey, Lynchburg, Va.

A. It is nigh-universally accepted in the audio industry that chrome tape is no more abrasive than other tapes. Some, in fact, claim that chrome tape is less abrasive.

Recording With Dolby Circuits

Q. When taping from one Dolby deck to another, is it better to record with both Dolby circuits on or to leave both off? Leaving both off means one would use the Dolby circuit on the second deck to process the Dolby signal produced by the first deck — John Clelen, Portland, Ore.

A. In theory it is best to "record with both Dolby circuits on," as you put it. This tends to insure flattest frequency response. In practice, however, good results — at least acceptable to the ear — are sometimes obtained by leaving both Dolby circuits off; that is, by playing the original tape with Dolby off and recording the copy tape with Dolby off. You might try it both ways and let your ears decide which is better. While theory provides a general rule (keep both Dolby circuits on), practice occasionally provides a useful exception. 

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.

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IT'S WORTH IT.

Behind the scenes

Bert Whyte

As any observer of the consumer audio scene is aware, the current recession in our national economy has wreaked considerable havoc in the audio components industry. Across the country, many of the smaller, inadequately capitalized audio dealers have gone bankrupt, victims of drastically curtailed sales of stereo equipment. Consumers have restructured their priorities, with the purchase of audio components relegated to a minor position. As the recession has deepened and with the imposition of severe restrictions on credit buying, even the bigger component dealers (including some well-known chains) have had to seek financial relief by entering into Chapter XI negotiations. As I write this, the Summer Consumer Electronics Show in Chicago is just a couple of weeks away, and it is being widely regarded as a "make or break" affair that will determine the current economic health of the entire industry.

I have recently returned from the 66th Convention of the Audio Engineering Society in Los Angeles, and it is gratifying to report that while there has been a moderate slowdown and some retrenchment in the world of professional audio, there is no comparison to the ills that have befallen the consumer sector. Oh, there may not have been the jaunty air of confidence and enthusiasm of other years, but in fact, the Los Angeles convention was as usual the biggest yet with more exhibitors than ever. However, it must be noted that apart from the expected activity in digital audio matters, there seemed to be fewer pieces of new equipment than one would have anticipated from the number of exhibitors present.

Early on at the convention, one of the main topics of conversation was

the joint announcement by Sony and Studer/ReVox that they had reached an agreement to support a common format in fixed-head digital audio recording. Studer will have access to Sony's digital tape recorder technology, and presumably there will be an interchange of information on Studer's R&D efforts in digital audio. The two companies expressed the desire that their common digital recording format

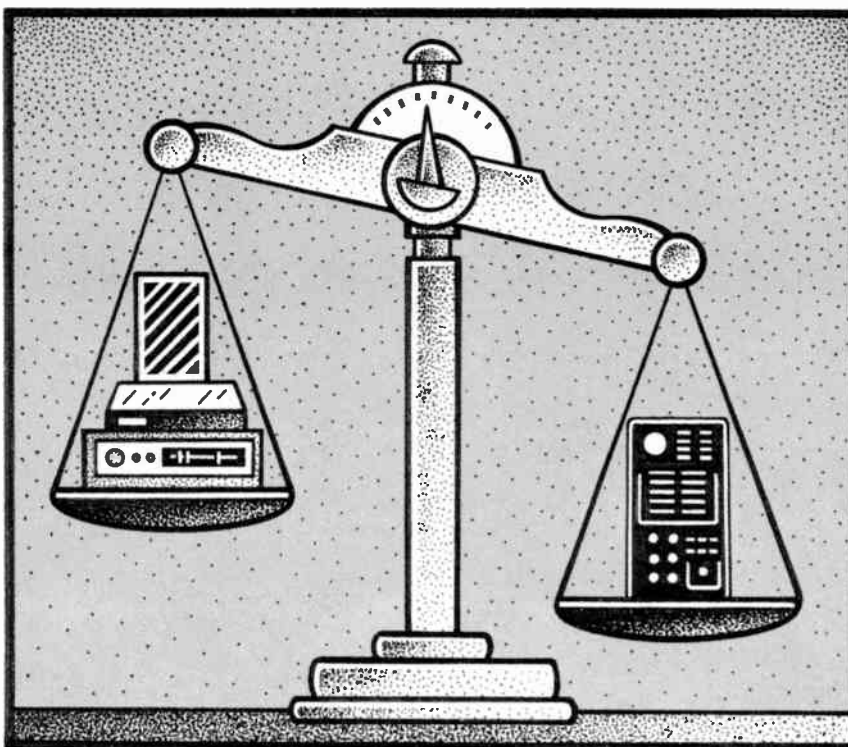
the Sony/Studer format is fully detailed to them. Sony and Studer are powerful organizations with great technological resources, so we will watch with interest the new developments from this unexpected alliance.

Digital Recording Systems

In other digital news, if you are an enthusiast for digital/analog hybrid recordings, Dr. Tom Stockham pointed

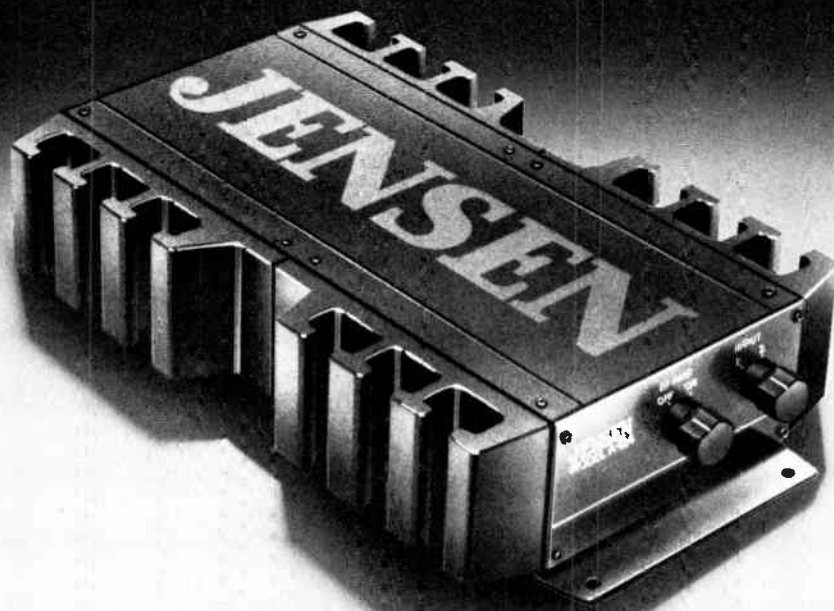
out that his Soundstream digital recording service has now produced 75 digital recordings. I, for one, didn't realize there were so many available. (Incidentally, Tom's pioneering digital recording of my Virgil Fox and Arthur Fiedler recordings will soon be available in the dbx encoded format.) There were also important developments in the digital area from Technics and JVC. Technics introduced the first fully digital recording system. Its elements include a four-channel digital fixed-head recorder using quarter-inch tape at 15 ips. The unit features a further refinement of

thin-film evaporated metal heads pioneered by Technics, which permit high-track density with low playback error rate. Each audio channel is recorded on four parallel tracks with new parity check and error correction techniques (16-track total). There are also four analog channels on the tape which were used for a control track, audio monitoring, SMPTE time code, and spare or voice cue. The recorder is a two-piece unit, one section for the tape transport (the by-now-familiar Technics closed-loop system) and servo system, the other section for the signal electronics. If higher multi-channel operation is desired, two or more of the recorders can be operated in parallel, synchronized by SMPTE



be accepted in the industry as an international standard. In other words, this joint endeavor is an attempt to establish, at least, a de facto standard. Other than the fact that the proposed format utilizes 16-bit linear encoding with multiple sampling rates (apparently 44.056 k, 50.4 k and 55 k) applicable from 2 to 48 (!) channels with new "high efficiency" codings for error protection and "high density" recording, no further information on the format was forthcoming. While the quest for digital audio recording standards is certainly laudable, most spokesmen for other digital tape recorder manufacturers I talked to were not bubbling with enthusiasm and said they would reserve opinions and judgments until

Power monger.



That's the Jensen A-124 Car Stereo Power Amplifier, all right. Distributing an F.T.C. Continuous Average Power Output of 100 watts into 4 ohms.

Not only does it have plenty of power to dispense, but it also knows just how to deal it out. To get the very most out of your system. And do the very most for your music.

A 4-speaker, bi-amplifiable unit.

The A-124 amp is an ideal low distortion power source for 4-speaker car stereo systems. Imagine a frequency response of 20 Hz to 50,000 Hz, ± 1.5 dB.

Flick a switch and it operates in the advanced bi-amp mode. Which is

perfect for 4-speaker systems or the new Jensen "separates" speaker systems which places woofers, tweeters, and midrange drivers individually throughout the car.

When switched to bi-amp, this amp displays its keen sense for a balance of power. Two 10 watt output-transformerless amplifiers drive the tweeters and midrange drivers for clear high frequencies. At the same time, two hefty 40 watt OTL amps in this unit distribute the forceful power needed to get full, low-distortion bass from the woofers.

The Jensen A-124 offers two different low level input capabilities, so that it is compatible

with both pre-amp and speaker outputs.

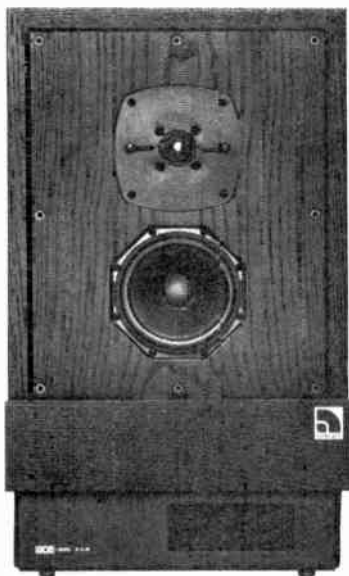
Thinking for itself.

When you turn on your stereo unit, the A-124 instantly comes to the ready, thanks to an automatic on/off switch.

It's instantly output short-circuit proof...just one of the many built-in protection features. And the unit comes complete with 15 meters of low capacitance shielded hook-up cable to eliminate RF interference.

So get the most out of your music...by getting the most out of your car stereo system. With the Jensen A-124 Amplifier.

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THE AUDIO PRO A4-14
BIAMPLIFIED LOUDSPEAKER

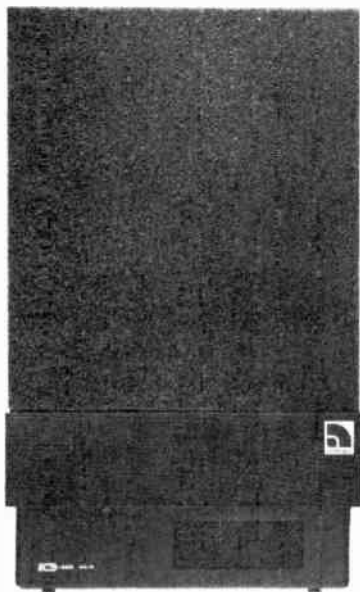
The only bookshelf-size* speaker with a built-in subwoofer.

Audiophiles tell us the ultimate speaker system uses bi-amplification and subwoofers. The bi-amplified A4-14's, with their built-in "ACE BASS" subwoofers are an entire audiophile system in bookshelf-size enclosures.

Acoustical engineers tell us that the ideal loudspeaker would be a single radiating point. Because of its built-in subwoofer, the Audio Pro A4-14 comes closer to this ideal than any other full range loudspeaker—without sacrificing bass.

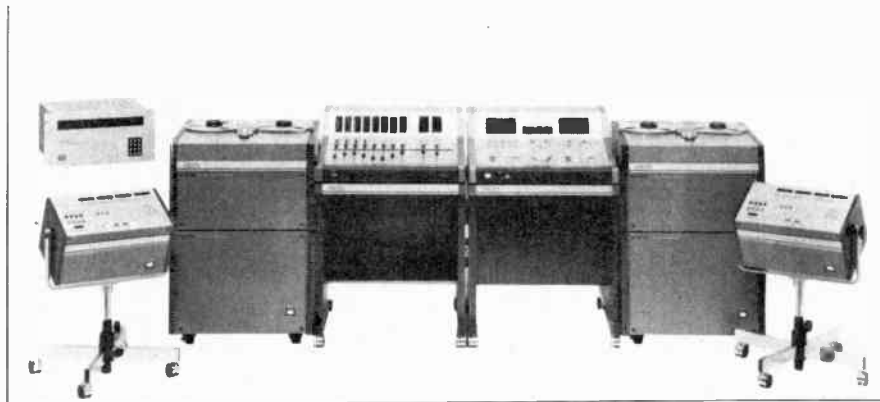
Designers tell us that speakers should be heard and not seen. Due to their compact size and full complement of room balancing controls, the A4-14's can deliver their optimum performance—wherever they are placed.

Sound, science, and style. The total design approach to audio.



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Digital audio recording system exhibited by Technics at the AES Convention.

time code. In the complete digital system, one machine is used for recording and another recorder for editing layout.

The next item in the Technics system is a unique digital editor, equipped with a solid-state memory and a variable rate read-out clock controlled by an operating knob. Slow-speed playback analogous to that in regular cut-and-splice editing is available through the slow rate read-out of the digital data stored in the memory. With two memories available to establish "in" and "out" edit points, the operator "rocks the tape" (as in time-honored analog fashion) with the control knob until he determines the edit points. The edit points can be previewed before execution of the actual edit, and enter and exit mode crossfades are possible for a smooth transition through these edit points. In the demonstration of the editor I saw, it was quite uncanny to hear the edit previews played back from the memory while the reels of the playback and layout tape recorders remained motionless! A digital audio mixer is the next part of the system. The unit can mix up to eight digital signals, down to a two-channel signal, and then divide it into four channels for the digital recorder. Each channel can be panned, and digital reverberation can be added on an outboard basis. The important aspect of this unit is that all signal processing remains in the digital domain. Lastly, there is the digital delay unit to interface with a disc cutter. Delay time is keyboard controllable from 0.1 to 1.6 seconds, in increments of 0.1 second. The entire digital system of recorder, mixer, editor, and disc preview uses 16-bit linear encoding with a sampling frequency of 50.4 kHz. Keeping all elements of the system in the digital domain is obviously the way to go. Unfortunately, Technics gave no information as to price or availability.

JVC introduced their Series 90 digital audio mastering system. The recorder here is the familiar U-Matic helical scan video-cassette unit using 3/4-inch cassettes. The recorder is used with the

JVC BP-90 digital audio recording processor, a two-channel PCM processor using 16-bit linear quantization and the usual 44.056-kHz sampling rate. It is claimed that the unit has a new high-efficiency error correcting code. The AE-90 digital audio editor is somewhat similar to the Technics editor. In the editing setup, there is one U-Matic VCR for playback and another for layout, plus the BP-90 PCM processor and the AE-90. Recorded music can be monitored audibly at the desired speed in either direction. In the search function, automatic or manual scanning can be used to locate the exact edit point. The AE-90 is said to have an accuracy of 45 microseconds. As in the Technics editor, rehearse preview of the edit is available from the memory, without running the tapes. Crossfade in and out at edit points is also available with four increments of time. In addition, JVC has the CD-90 digital audio delay unit for furnishing a preview signal to a disc cutter. At any sampling frequency, delay time can be up to 1.5 seconds in six-millisecond increments. With input for 16-bit data, the dynamic range of the delayed signal is more than 90 dB. If controlled by an external clock signal, the unit can be operated at sampling frequencies from 30 to 60 kHz. What appears to be missing in this system is a digital mixer, but perhaps that is forthcoming. JVC seems to be deadly serious about this system, as delivery is quoted as "late July" of this year. No price given, but rumor has it in the neighborhood of \$120,000.

U.S.S. Amplifier

As is usual at AES conventions, the mixing consoles get ever bigger and more complex. Automation is virtually a necessity, as even the most octopus-armed mixer can't cope without it. The huge Neve Necam automated console that was being demonstrated at the convention was purchased by my ever-venturesome friend Bill Putnam for his United Recording studios. Bill's UREI company introduced a brute of a power amplifier, Model 6500. Designed as a high-quality unit with high

output power for professional monitor and "road show" applications, this amp is built like the proverbial battleship. It has modular amplifier assemblies, accessible from the front panel. Each amplifier module is equipped with a variable-speed cooling fan. The 6500 has a unique conductor compensation circuit (no, Virginia, it doesn't help bad music conductors!), which includes the speaker wires in the main feedback loop of the amplifier and corrects for wire losses in long runs. With this circuit high damping factors and high peak current capability are maintained. Power output is 275 watts/channel at eight ohms, all the way to 600 watts at two ohms, and in mono bridged mode, a very healthy 900 watts into eight ohms at 0.2 percent THD. Slew rate is listed at 50 V/ μ S. The amplifier is just now going into production.

Here and There at AES

Other interesting items that caught my eye while wandering around the exhibits ... Sansui's new "feed-forward" amplifier, said to completely (!) cancel all distortions at the output stage, is apparently ready for production ... Crown now in production of the Barclay Badap analyzer and the new PZM microphones. In another move Crown is making to further increase its involvement in professional audio, they will be making a dedicated instrument for the Energy Time Curve (ETC) measurement techniques, the brainchild of our own Dick Heyser, under license from Cal Tech ... How about a 24-channel recorder using two-inch tape, in two portable cases from Stephens Electronics? ... Or Neal-Ferroglyph's Model 312 cassette deck, metal capable, sporting the new Dolby HX system, and a nice three-motor, solenoid operated transport ... Jerry Bruck, that genial importer of the superb Schoeps microphones, had two intriguing items in his exhibit in aid of better quality stereo recordings. One is the UMS 20 Schoeps universal stereo bracket. This \$275 device has clamps to accept various Schoeps mikes. By sliding them along a metal bar, adjusting their angles and aligning a series of colored dots, the specific mikes are properly positioned to make stereo recordings according to the Blumlein, XY, MS and French ORTF techniques. The second item is from Wes Dooley's Audio Engineering Associates in Pasadena, an active MS matrix decoder, the MS38 (distributed in New York by Jerry Bruck). As you may know, in MS stereo recording, the M (mid) pickup is a cardioid mike facing forward to the source, picking up the main overall sound image; the S (side) mike is a figure-eight pattern picking up lateral

directional information. The two mike outputs must be combined in a sum and difference matrix (M+S and M-S) to produce conventional left and right stereo signals. By adjusting the relative balance of M and S signals into the matrix, variations of the stereo perspective are possible. This MS technique affords stereo sound with a very natural balance, with precise imaging, depth and instrument localization. Heretofore, matrix networks with transformers had to be used, with the attendant degradation caused by the iron in the transformers. Hence, the MS technique was not used as much as it deserved. But the AEA MS38 uses modern solid-state circuitry, no

transformers, and as I heard it, is an immaculately clean device. A single knob controls stereo perspective, and interfacing with the recording chain is simple. If the tape you are recording has the original MS signals and if the playback is connected to the inputs of the MS38, it will be decoded directly into conventional left/right stereo sound. With most digital recorders being two-channel units (except 3M), these mike pickups are worth any engineer's attention.

Now we'll have to wait until November at the Waldorf in New York for the 67th AES Convention and further digital developments. I can tell you there will be some surprises! Δ

SIGNIFER

The sublime...

Amid the wealth of accomplishment of audio technology worldwide, the design of loudspeaker systems conferring accurate, natural, truly musical sound reproduction remains essentially a sphere of British eminence.

With their CARNIVAL, FESTIVAL and PAGEANT speakers already acclaimed in countries throughout the world, Mordaunt-Short Ltd. of Southern England have perfected a further model of surpassing excellence, aptly named SIGNIFER (Latin: Standard-Bearer). The product of all that is best in Britain, the SIGNIFER represents the best of British products amongst products of which the British are still acknowledged best.

For an audition of SIGNIFER, see your Mordaunt-Short Dealer or write to us and find out more about the best that Britain has to offer.

Wherever sound reproduction must attain the highest standard,

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What's new

VMPS Loudspeaker

The Super Tower II, a minimum phase response speaker, is said to produce no more than 0.25 percent THD over the range of 22 Hz to 20 kHz with 1 W input. Sensitivity is rated at 103 dB/watt/meter, and low-frequency cut-off is at 17 Hz (-3 dB). With the rated maximum input, maximum undistorted output is 132 dB/meter. This 300-lb. model may be biamped without an external crossover, and its power handling capability is 500 W rms. Dimensions are 21½ in. x 76 in. x 17 in. Prices: Kit, \$799.00 each in black and \$949.00 each in rosewood; assembled, \$1,299.00 each in black and \$1,499.00 each in rosewood.

Enter No. 100 on Reader Service Card

Sony Cassette Player

Sony's Walkman stereo cassette player, Model TPS-12, is barely larger than a standard cassette yet it weighs only 13¾ oz. and produces sound quality comparable to all but the best home hi-fi gear. The player comes with the Model MDR-3 headphones shown and will accommodate an optional second set of the 1½-oz. phones. The player has separate right- and left-channel volume controls and a treble control, while the Hot Line mike allows talking or singing over the program on the tape (though not recording). Price: \$199.95.

Enter No. 101 on Reader Service Card



Ace Audio Ground-Loop Eliminator

Model 3900 Ground Eliminator is designed to break up ground-loop faults in connecting cables and thereby improve the hum performance on a stereo system. The unit contains only passive circuitry and cannot introduce distortion of any kind. Price: Wired, \$16.00; kit, \$14.25.

Enter No. 102 on Reader Service Card

Amber Distortion/Noise Measuring Set

Model 3500 is a high performance distortion and noise measurement system incorporating an ultra-low distortion sine-wave oscillator, a THD-plus-noise analyzer, a wideband and weighted true rms level meter, and a tunable band-pass filter. The unit will measure signal level, frequency response, wideband noise, weighted noise, narrow-band noise, crosstalk, and total harmonic distortion, and there is an IM measuring option. Features include auto-set-level and automatic nulling, while tuning is via a single continuously variable control, which covers a frequency decade, and four push buttons which select one of four decades. THD measurements can be made as low as 0.001 percent, while harmonics of the oscillator at midband at greater than 110 dB down and the fundamental rejection in the analyzer exceeds 120 dB. Price: \$1,600.00.

Enter No. 103 on Reader Service Card



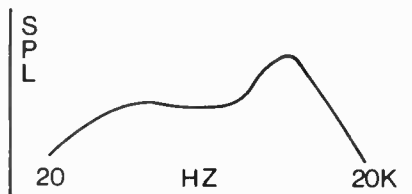
The electrostatic dream finally realized with conventional power amplifiers.

The problem.

Full range electrostatic speakers first appeared about 25 years ago. They were segmented designs with separate woofer, mid-range and high frequency drivers. To secure necessary drive voltages transformers were used. This segmentation of the audio spectrum was done almost exclusively to accommodate the limitations of the step-up transformers. There was *never* any limitation preventing each electrostatic element from being full range. The laws of physics suggest in fact the opposite, that *only* the electrostatic element with its exceedingly low mass diaphragm and uniformly distributed drive forces is theoretically or practically capable of low-coloration full-range response. It became apparent to several manufacturers, including ourselves, that a *full-range element* electrostatic loudspeaker would most closely approach the ideal transducer. At this point *full-range element* development split into two paths: 1) single-transformer drive and 2) the use of dedicated high-voltage amplifiers (omitting step-up transformers). Acoustat has supplied more dedicated amplifier-speaker combinations than any other company in the world. The superiority of the *full-range element* concept is substantiated by the many superlative reviews these types have received in the audiophile press.

The use of a conventional power amplifier with *any* electrostatic will obviously require audio step-up transformers.

In our research over many years, we have continuously re-verified the predictably unsatisfactory results obtainable from an attempted full-range single step-up transformer:



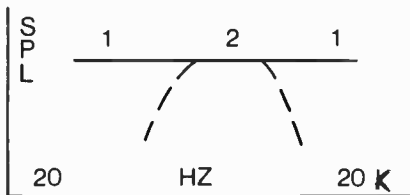
A summary of single-transformer design problems include: 1) Very high power for adequate SPL; 2) A nasty reactive load for the amplifier with wild impedance changes; 3) Unacceptable response irregularities (large resonant

peak in upper midrange, inadequate bass and high-frequency response), and 4) High acoustic throughput of transformer-induced distortion.

The solution.

Acoustat concluded that a new method would be required if these problems were to be resolved. That solution is an elegant yet simple invention which we call the Magne-Kinetic Interface (and bias supply) Model MK-121 (Patent Pending).

The MK-121 has a unique two transformer configuration or "Biformer" design. The two transformers run in parallel signal paths with both transformers driving the speaker in the critical midrange or center third of the audio spectrum. Each transformer comes into its own extended range for the lower and upper thirds of the spectrum:



Single-transformer drive requires the acceptance of many compromises. With the MK-121 there are virtually none. The 600:1 bandpass-frequency-ratio required by a single transformer is reduced by more than ten times! The "1-2-1" band-handling and the

listening environments. Considerably more efficient than typical "high-end" cone systems.

2) A pleasantly manageable load for the power amplifier in both magnitude and phase domains. Excellent power-impedance match.

3) Superior phase characteristics (much closer to resistive), which reduce amplifier and speaker colorations.

4) Remarkable spectral flatness in the total system providing tighter extended bass response, a midrange with breathtaking definition and imaging, and vastly extended high frequency performance.

5) Higher sound pressure level, about 3 db higher than with our Servo-Charge amplifier (which was never considered level shy).

6) Compatibility with all Acoustat speakers, past and present.

7) An almost \$1000. price reduction over our original Servo-Charge system for reference quality performance unmatched by any speaker system regardless of price.

ALSO AVAILABLE:

- MONITOR FOUR-121 \$1995/PR.
- MRP-1 PREAMP \$950 (STP Head Amp.)

MONITOR
THREE-121
\$1650/PR.



BEHIND EACH SPEAKER:
MK-121 MAGNE-KINETIC INTERFACE.

resynthesis method used result in absolute minimization of all natural transformer limitations (saturation, hysteresis, resonance, inductance and capacitance).

The advantages.

1) A ten-fold increase in efficiency over single-transformer *full-range-element* designs. 50 watts per channel is all that is necessary in most typical

ACOUSTAT
corporation

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Fort Lauderdale, Florida 33315
Phone: 305/462-6700

What's new

Mordaunt-Short Loudspeaker

Mordaunt-Short's Pageant Series 2 is a bass-reflex, two-way type covering the frequency range of 25 Hz to 25 kHz, with a crossover point at 3.5 kHz. Ratings are impedance at 8 ohms nominal, sensitivity 5.3 watts for 96 dB SPL at 1 meter (anechoic), maximum SPL 110 dB, and THD less than one percent. The speaker, which the manufacturer recommends placing a minimum of one foot from the floor, incorporates a single bass- and mid-frequency transducer and a dome tweeter. Each speaker measures 21 x 13 x 9 inches and weighs 21 lb., 1 oz. Price: \$595.00 per pair, including stands shown.

Enter No. 104 on Reader Service Card



Omnisonix Imager

Model 801 Omnisonix Imager™ creates a realistic sonic image from stereo, allowing the listener to experience what amounts to three-dimensional sound reproduction. A stereo signal from the tape-monitor loop in a conventional system is fed through the unit. From two speakers, the sound then seems to come from many sources:



In front of, behind, to the sides, above, and below the listener—depending on the signal source and the system used. The imager's frequency response, ± 0.5 dB, is said to be 10 Hz to 100 kHz; THD is claimed to be less than 0.005 percent over the range of 10 Hz to 20 kHz. Hum and noise output is -80 dBV, and S/N is greater than 98 dB. Price: \$179.95.

Enter No. 105 on Reader Service Card

Modular Acoustics Loudspeaker

Model 3000 is a Helmholtz dual-port resonator type tuned to two specific frequencies approximately an octave apart. The higher frequency tuning permits acoustic loading in the mid-bass region, while the lower frequency tuning maintains loading to a very low frequency limit. Impedance is rated at 8 ohms, frequency response is specified as from 25 Hz to 20 kHz, crossover frequency at 2 kHz, and maximum power at 100 W rms. An 8-in. woofer and 1-in. soft dome tweeter comprise the drivers incorporated in this 65-lb. unit, which measures 26½ in. x 19 in. x 12¼ in. Price: \$250.00 each.

Enter No. 106 on Reader Service Card

Janorhurst Ltd. Turntable

The JBE Series 3 manual, direct-drive, two-speed turntable is manufactured in England and available in the U.S. through Lights Fantastic. The weight and density of the solid Welsh slate used in the base cause the turntable to reject both acoustic feedback and outside resonance. The platter, to which six precision-machined aluminum discs are fitted, is said to be virtually acoustically dead because of the combination of heavy acrylic and solid aluminum bar used in its make-up. Wow and flutter (DIN) is specified at 0.07 percent and rumble (DIN "B") at 72 dB. Price: \$795.00 without tonearm.

Enter No. 107
on Reader
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TEAC

TEAC TODAY: THE ALL-TIME LOW IN TAPE NOISE.

On paper, the specifications* look unbelievable:

80dB signal-to-noise ratio, 95dB dynamic range and 15dB more headroom than you've ever had.

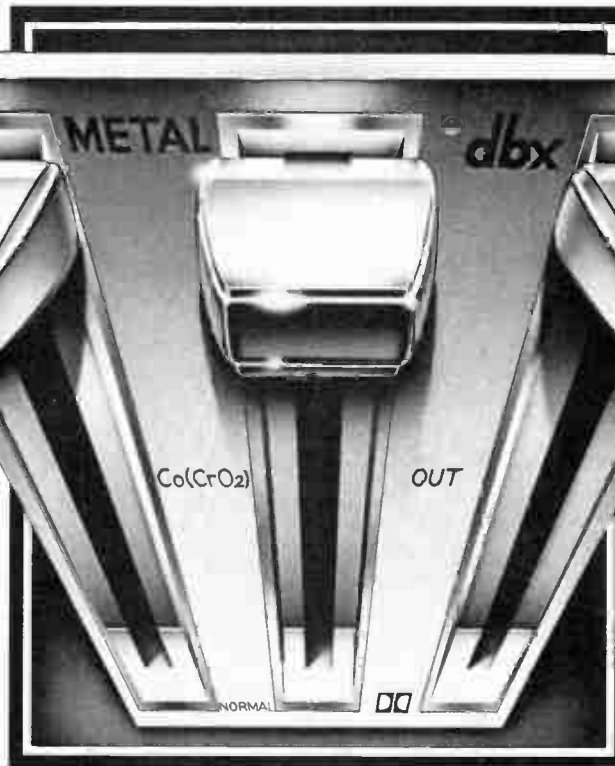
The sound is so noise-free, it's scary. And once you listen to the audio performance of the A-550RX, you'll know that cassette recording will never be the same.

You'll hear signal without noise or hiss. Louder louds and softer softs. And you'll never have to be bothered by tape saturation again. All this because the A-550RX is the only mid-priced cassette deck ever to include integral dbx** noise elimination plus complete metal tape capabilities.

A few years ago, the dbx system helped us revolutionize professional recording. Now the same technology is helping us move cassette performance into a new era.

On the A-550RX, dbx II gives you broadband noise elimination and dramatically improved dynamic range. Signal articulation that's better defined than anything you've ever heard from a cassette tape.

And the A-550RX doesn't stop there.



Its designed to handle all the new metal tape formulations. Which means you get the unprecedented performance of dbx II with the additional improvements provided by metal tape.

You'll hear the all-time low in tape noise. The all-time high in dynamic range.

Peak reading dB level meters help you get as much signal on tape as possible without distortion. And clutched record level controls make adjustments faster and easier.

To make sure you have complete compatibility with your current tape library, the A-550RX has Dolby NR† as well.

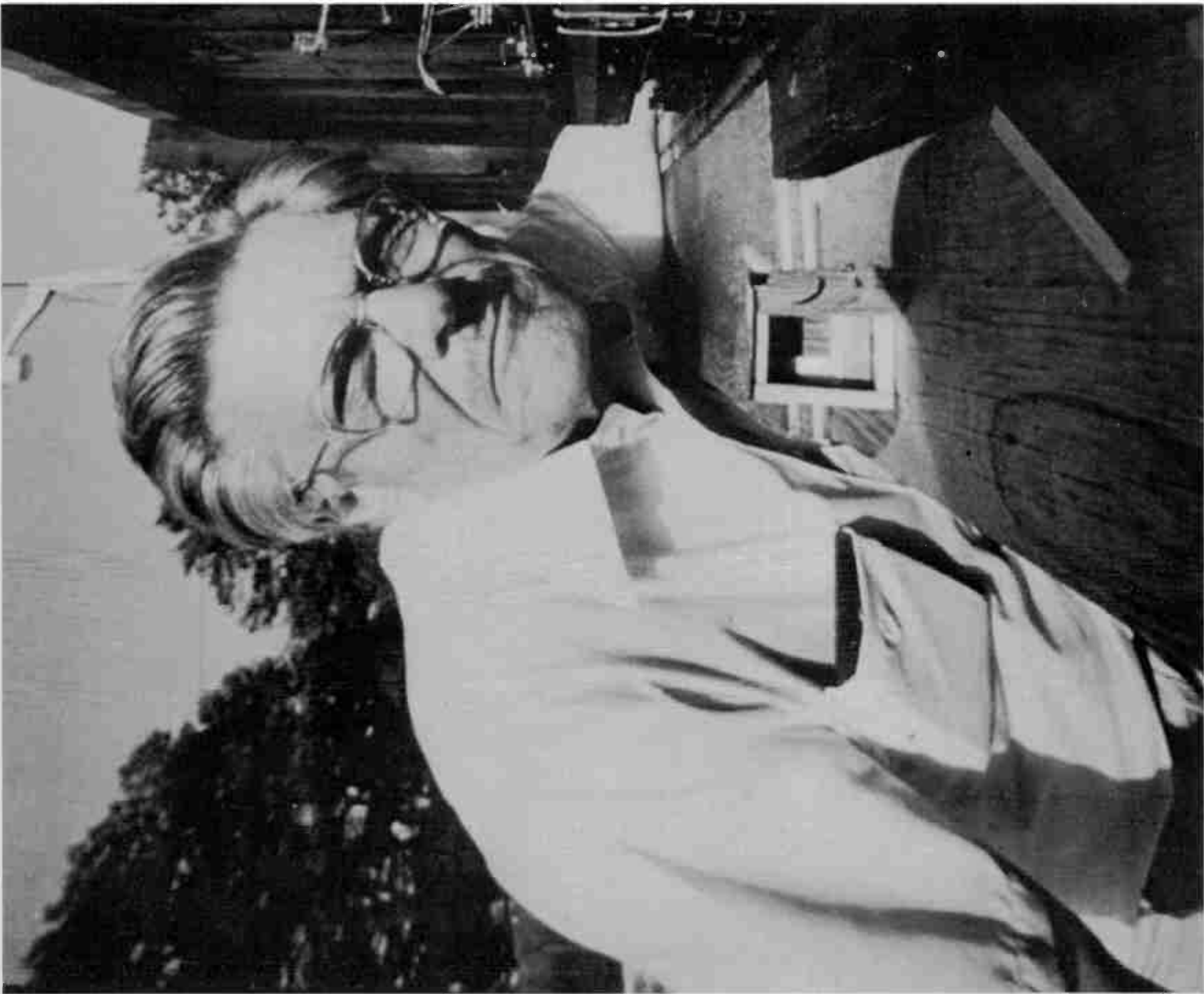
Full logic micro-switches control the high-stability transport. The A-550RX accepts our RC-90 remote control unit. And rack mounting hardware is available optionally. So listen to something you've never heard before.

The amazing A-550RX. You'll hear completely noise-free cassette recordings with the broadest dynamic range available.



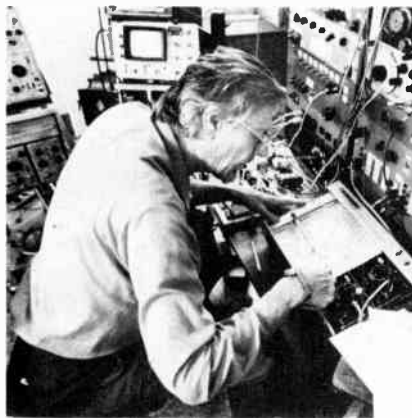
TEAC

*Measurements made with metal particle tape
**dbx is a trademark of dbx, Inc.
†Dolby is a trademark of Dolby Laboratories



Paul Klipsch— Arkansas Speaker Maker

Bob Browne & Gary Stock



“ As far as I’m concerned, since 1940 the advances in loudspeakers have been largely in detail rather than in basic principle. ”

January 14, 1980. I’m on my way to Hope, Arkansas (population 8,800) to talk with Paul Wilbur Klipsch, a man apparently so fascinating and so eccentric that no one who hears the tales about him can separate fact from fiction. The trip begins characteristically: I’m met at the Texarkana airport by a tobacco-chewing, unshaven, Stetson-crowned fellow who looks as if he has been in the middle of the Hatfield-McCoy feud for 20 years. He carries the moniker “T.C.” — for Tommy Crouch — and just happens to be the Executive Vice President of Klipsch and Associates. Early on I realize that T.C.’s hayseed drawl covers an ability to cut the wheat from the chaff quicker than most, and I learn to treat him with the same deference I’d show to Swifty Lazar or a top Wall Street attorney. Most of the Klipsch management is like that.

T.C. tells me I’m staying at the Klipsch Compound. Sounds foreboding until we arrive there, and I find it to be a rather luxurious upper middle

class home, equipped with the amenities that are apparently most important in Hope — 300 assorted beers in the fridge and a mega-sound system capable of knocking over NFL linebackers at a hundred paces. My ears ring for the remainder of the evening.

I meet the leader the day after I arrive, not knowing whether to expect a rip-roaring cowboy with a slide rule in his holster or just a slightly rusticated Werner von Braun. The initial impression is that Klipsch, all six foot-three of him, is both, with a healthy dose of knee-slapping wit thrown in for good measure. His humor is too broad and too relentless to be called “whimsey”; it’s closer to that of a Country and Western stand-up comic. As I wander through the factory and through PWK’s life, evidence of his quest for a good laugh is everywhere. There’s a beer tap bolted to the instrument panel of his airplane, an aircraft altimeter on one of his living room Klipschorns, and a huge manifold pressure gauge (perhaps from a railroad locomotive)

horn loudspeakers the efficiency — the horsepower output, call it — is typically one to three orders of magnitude higher and the distortion proportionately lower than in a direct radiator. Admittedly, the direct radiator is the less expensive, "cost effective" approach, and it will never be replaced because horns are vastly more expensive to build. But if you look at it in terms of horsepower per unit cost, then the horn suddenly becomes much more cost effective — raising the point that the total music system may cost less for a given level of performance if the speakers cost more and yet require a much smaller amplifier. This brings in my much-quoted remark that what this country needs is a good five-watt amplifier.

Audio: What should a speaker do in order to be popular with the general public? Are most buyers looking for accuracy of reproduction?

Klipsch: First off, I don't even consider myself a member of the general public. I know that my own requirements in a loudspeaker are those I've discussed. Judging from what contact I have with the general public, though, I conclude that 99 percent of the general public doesn't even know what accuracy of reproduction is. My company is for the one percent composed of perfectionists who buy these expensive speakers.

Audio: How do you react to the statements by some audio enthusiasts that all horn-type speakers have intrinsic coloration — a particular sonic character, as it were, that is inherently unnatural sounding?

Klipsch: Many years ago I recall read-

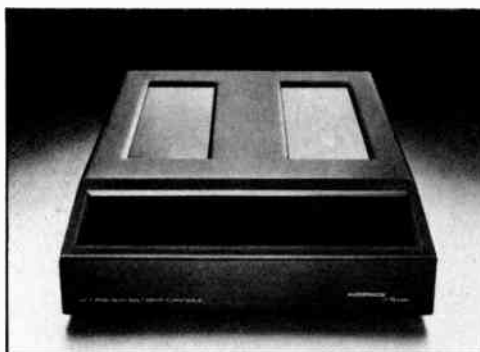


ing an article about the retirement of David Sarnoff as the Chairman of the Board of RCA. He was reminiscing in the story about one of the earliest electric phonographs, developed by Victor just after it had been acquired by RCA. It sounded miles better than the phonographs of the day, but Sarnoff remembers someone in marketing listening to it and saying "I don't think it will sell; it doesn't sound like a phonograph." There's a good point there: Many people would prefer that a music-reproduction system sound like a machine, rather than like music.

If you take any kind of speaker — horn or direct radiator — lop off the lows below 300 Hz, attenuate the upper treble, and inject some scratchi-

ness, people will say "it sounds like a horn." That's because it has a restricted frequency range; it would be like using one of our Klipschorns with only the midrange driver connected. It would sound like a Twenties phonograph. The point I'm making is that so-called horn coloration is a function of the frequency response. A wide-range horn, like any of the speakers we make, will have no substantial coloration. You can make any horn sound like any direct radiator, if they both have wide, flat frequency response. But the horn will always sound cleaner because it will always have higher output for lower distortion. That's why I'm in the business of making horn speakers. A

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“Listening tests confirmed what the excellent measurements implied: the Eumig FL-1000 is a superb performer.”

JULIAN HIRSCH—STEREO REVIEW, APRIL 1980

What you are about to read is Julian Hirsch's unedited conclusion in his review of the Eumig FL-1000.

“Listening tests confirmed what the excellent measurements implied: the Eumig FL-1000 is a superb performer. Dubbing from FM or phono discs revealed no audible differences between the original and the copy, and even FM interstation noise—our most severe test—could be recorded and played flawlessly up to levels of approximately -5 dB. The Computest adjustment for different brands of tape was not only accurate but contains a built-in rewind mechanism that returns the tape to the precise point where you began your adjustment. The counter was the most accurate we have ever used. And for people who are “into” computers, the one-of-a-kind (so far) Eumig FL-1000 cassette deck opens up endless possibilities.”

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World Radio History

Alternative Speaker Technologies

Gary Stock

The time is the mid-'30s, and as Mussolini raves and war clouds gather over Europe, a British professor named MacLachlan is putting together one of the first texts on a new and interesting if minor device — the loudspeaker. Sensibly enough, the book will be called *Loud-speakers* (how the English love their hyphens). MacLachlan does not have much prior art on which to build, since the direct-radiator loudspeaker debuted a scant nine years earlier. But in that brief period, he has managed to collect information on a reasonable array of sound-producing gizmos. He describes conventional cone-type loudspeakers with cones made of doped cloth, an amazing lightweight metal called duralumin (now known by the prosaic name "aluminum"), and a fairly new and exotic plastic called phenolic. He briefly covers the crystal earphone, describing how some minerals flex when an electric current passes through them, and can therefore be used to move small diaphragms and produce sound — but that is old hat to him. More space is devoted to a new idea called the condenser loudspeaker, a device composed of two plates separated by a thin layer of felt. One moves, the other doesn't, he notes, and though that in itself suggests a certain amount of intrinsic distortion, MacLachlan is hopeful that the bugs can be worked out. There is a short discussion, too, of a German *wunder-lautensprecher* called the Blatthaller, which consists of a supported rigid plate with a voice-coil zigzagging across the back through a carefully complementary zigzag ar-

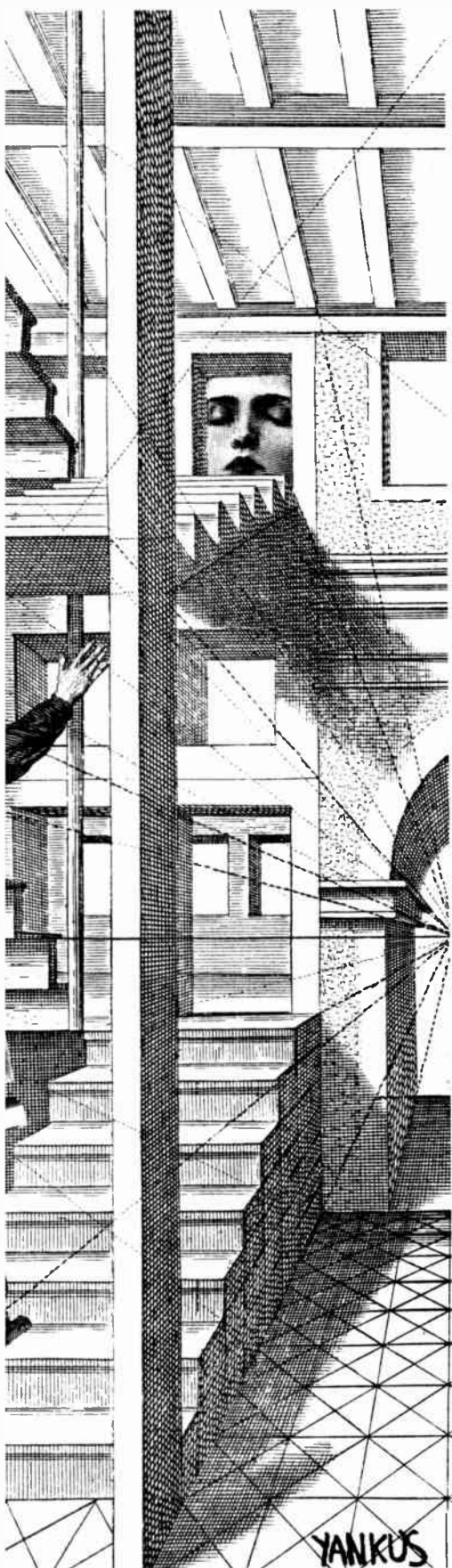
range of magnets. It is said to sound remarkably lifelike. With Scottish thoroughness, MacLachlan documents, diagrams, annotates, describes all of these devices, carefully but diplomatically details their strengths and weaknesses, and then makes discreet predictions as to their future value.

Forty-five years later, we are finally entering a new age in loudspeaker design — an age in which the supremacy of the technically untidy but ubiquitous moving-coil loudspeaker is for the first time being strongly challenged by the exotic transducer types described by MacLachlan. It has taken this long because only recently have the materials and processes — high-energy magnets, plastic films, vapor-deposition processes, etc. — necessary to produce reasonably priced versions of these "alternative transducers" become widely available. But every one of these concepts, as well as a few genuinely new wrinkles, is finally coming to the marketplace in some commercial form. Today's speaker engineer has more practical, interesting, and innovative options than at any time in the past 40 years.

This same range of options, of course, is also available to buyers of loudspeakers, and in order to help clarify the new choices that speaker purchasers have, we have assembled this guide to the transducer types. It is divided into six sections, including a review of the moving-coil principle for reference purposes. The distinctions between the various classes of transducer are not always clear ones, and some commercial examples, in fact,



Illustration: Marc Yankus



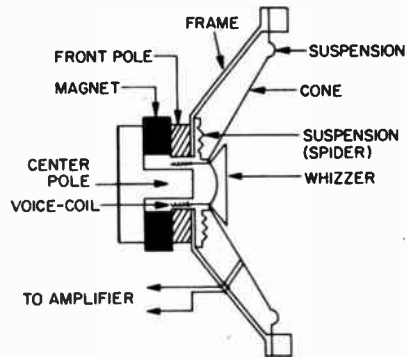
YANKUS

neatly straddle the line between one type and another. Our classifications are therefore only approximate, and our commentary on the merits and disadvantages of each is *generally* but not *universally* applicable. For those with an interest in the detail of the engineering techniques behind these concepts, we also provide a bibliography, broken down by transducer type.

The Moving-Coil Driver

also called the *dynamic, electrodynamic, or cone-type driver*.

Like the internal combustion engine, the moving-coil loudspeaker is a Rube Goldberg-esque idea that has been made to work by dint of 50 years of painstaking twiddling and tweaking



Conventional moving-coil speaker.

of its innards. Yet work it does, and sometimes very well. In terms of simple theory, this type of driver is a sort of fast-moving solenoid attached to a larger, flattened diaphragm that may be planar, dome or bowl shaped, ring-like, or most commonly, a shallow conical frustum. As detailed in the accompanying diagram, current flow through a tubular coil, which is immersed in a ring-shaped magnetic field, generates longitudinal motion; the attached diaphragm couples this motion to the air and induces the pressure variations that constitute sound. A number of problems are obvious. In the magnetic circuit, the field produced by the magnetic structure is uneven due to various fringing effects; either the coil or the magnetic gap must be longer than its mate in order to linearly accommodate the range of the driver's motion. On the diaphragm side of the device, one obvious difficulty lies in making the entire diaphragm surface precisely follow the coil's motion, particularly since the rather low efficiency of the magnetic motor system requires that the total moving mass of the speaker be kept

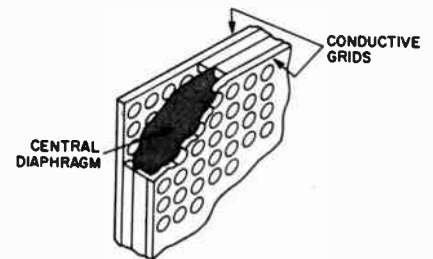
low. Most of the "black art" of moving-coil speaker design, in fact, revolves around the details of cone shapes, paper mixtures, and adhesives to minimize the effects of nonlinear cone motion. The vast majority of the irregularities found in any loudspeaker response curve are due to dozens of minor resonances, nodes, anti-resonances, and phase cancellations taking place as the radiating surface wobbles back and forth.

Despite its difficulties, the conventional cone-type loudspeaker has been developed to a fairly high level. Motor systems that compensate for magnetic irregularities, synthetic diaphragm materials formed into flat plates or constructed in rigid sandwich-type composites, and system designs with enclosures and dividing networks which compensate for many of the time-domain irregularities of moving-coil units have all been investigated in recent years, with good results. And the advent of heat-sinking magnetic fluids and high-temperature voice-coil assemblies have improved power handling capabilities of cone-type units to the point where they are the unquestioned driver format for very high-power applications.

The Electrostatic Driver

also called the *capacitor or condenser-type loudspeaker*.

As the name implies, electrostatic drivers employ the attractive and repulsive forces that exist between electrostatically charged surfaces in order to generate sound. The conventional arrangement, first developed in the '30s (shortly after the publication of MacLachlan's book) places a single



Electrostatic transducer.

thin-film diaphragm with a very high surface resistivity between two acoustically transparent, electrically conductive grids. A fixed high-voltage charge on the center membrane causes it to be attracted to the varying voltage on one of the outer grids while it is simultaneously repelled by the reversed

voltage of the other grid, the two grids normally receiving out-of-phase musical signals from a high-voltage amplifier or from a step-up transformer. This arrangement, in which both grids act to maintain a constant force on the diaphragm regardless of its displacement from the center position, is called push-pull for obvious reasons. It was the improvement that brought the single-sided electrostatic drivers of MacLachlan's day, with their high intrinsic distortion due to varying driving force as the diaphragm moved closer or fur-

ther from a single grid, into the realm of high fidelity.

The virtues and difficulties of the electrostatic concept are clear even in this simplified description of operation. The diaphragm, being uniformly driven and of low mass with little in the way of self-resonant properties, can be expected to exhibit piston-like performance with very little coloration over a fairly wide frequency range (limited typically at the low end by the fundamental resonance of the diaphragm as a whole, and at the high

end by the inductance of the step-up transformer or the frequency response of the driving high-voltage amplifier). By the same token, its excursion will be limited to the spacing between the diaphragm and the grids, and its output by the dielectric properties of air, since an extremely high polarizing voltage will arc across the air gap between the two. These factors have traditionally worked in concert to limit the dynamic range of electrostatic units and to mandate that they have fairly large, and therefore narrowly-dispersed radiating surfaces, although a number of innovative solutions have been developed in recent years. One is Dayton-Wright's use of an envelope of gas having much higher dielectric strength than air surrounding the drive elements. Another is the Beveridge approach, in which a large diaphragm radiates into a sort of sectoral horn, terminating in a tall, narrow slot, thus making the system a line-source radiator. An even more unusual approach is the one employed by BTM in their ESTranslator series, in which a single central grid is placed between two diaphragms (see bibliography for an early paper on this design format), eliminating the need for high polarizing voltages. Other electrostatic drivers on the horizon may include self-polarized electret-type drivers (already used in some headphones), if the permanent polarizing electret charge can be increased to a higher level by new techniques.

The Planar-Dynamic Driver

also called the *planiform*, *magnetodynamic*, or *distributed coil driver*.

An exceptionally attractive (to the speaker designer) synthesis of the strong points of cone-type dynamic and electrostatic driver types, the planar-dynamic driver type is perhaps the fastest-growing alternative driver type today, currently used in at least 30 commercial loudspeaker systems. As shown in the accompanying figure, a film diaphragm is suspended between two perforated or slotted magnet arrays, with a pattern of conductive lines on the diaphragm surface arranged so that the leakage flux from the magnet gaps drives the diaphragm in a push-pull arrangement (single-ended versions do exist, however). The driving surface is usually nonresonant, acoustically resistively loaded, like an electrostatic diaphragm, and more or less uniformly driven, depending on the density of the signal-carrying pattern of lines. The load on the amplifier is stable, in contrast to both moving-

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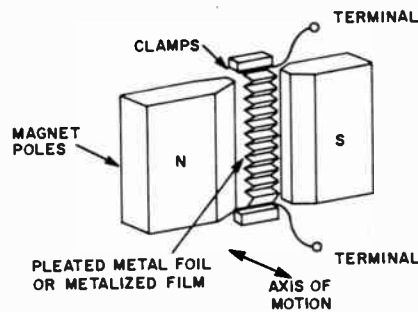
coil and electrostatic formats, and presuming the use of a high-temperature plastic, and a fairly thick copper or aluminum pattern, the power handling can be made fairly high. Since the diaphragm mass is usually low, efficiency is controlled largely by the flux density of the moving system — and therefore in turn by the distance between the magnet structure and the diaphragm, as well as the energy product of the magnets themselves. This has led to the use of samarium cobalt "rare earth" magnets in many of the current examples of the genre, although units using conventional alnico and ferrite magnet materials have also been made. Interesting wrinkles in the first generation of designs include Strathern's use of non-driven film sheets adjacent to the diaphragm as a means of damping resonances, and Cerwin Vega's SUFT-FET drivers, which employ a single spiral track that covers almost the entire diaphragm surface. On the horizon are less expensive large-diaphragm versions, with area reduction as frequency rises to maintain good dispersion, and narrow strip-style full-range planar-dynamics with line-source dispersion characteristics.

The Ribbon Driver

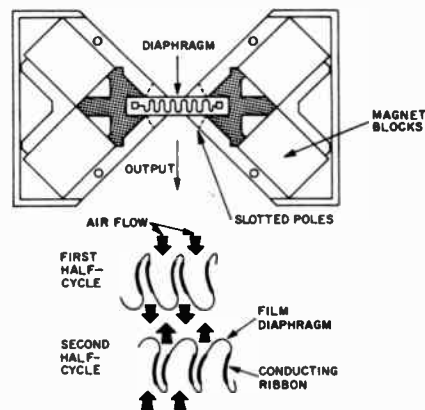
also called the leaf driver.

An approach used by only a handful of manufacturers in past years — Fane and Decca were for decades the only keepers of the ribbon faith — the ribbon has recently received a great deal of research and support in the Far East, as well as the support of a number of adherents in this country. One of the simplest transducer types, a ribbon consists of a narrow conductive diaphragm running lengthwise through a slot-shaped magnetic field, the diaphragm usually consisting of either an aluminum foil or a metalized plastic like aluminized mylar. The motion of the diaphragm is lengthwise, and the entire radiating surface consists of the ribbon's front and rear surfaces. Advantages include uniform drive and a consequent lack of diaphragm break-up and resonance, extended high-frequency response, and (generally) good horizontal dispersion at high frequencies due to the narrowness of the radiating surface. Efficiency is generally very limited because of the fairly low flux densities permitted by the wide magnet gap and the small radiating area, and the excursion and power handling capabilities of the format are also usually fairly low. Among the design techniques commonly used to improve performance are horn loading of

the diaphragm as a means of improving efficiency, pleating of the diaphragm as a means of increasing maximum excursion capability (the pleats "unfold," as it were, at peak amplitudes) and diaphragm rigidity, and the use of matching transformers to match the low impedance of the diaphragm — often only a fraction of an ohm — to the requirements of conventional amplifiers.



Ribbon transducer.



Heil "Air Motion Transformer" (courtesy ESS).

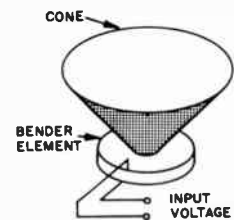
Among the interesting variations on the design type, Pyramid has developed an arrangement of rubber strands that fasten to the edges of the diaphragm and prevent twisting and non-pistonic motion, while Impulse has a wide-range ribbon system in which a metalized plastic strip several feet tall is used to generate a dipolar, line-source sound field. Another innovative variation, and one that has enjoyed enormous commercial success, is the Heil Air Motion Transformer, a system in which a folded plastic sheet with a ribbon attached to it operates by compressing and expanding along the folds in accordion-like fashion, thus generating high output levels (see the accompanying figure). The Heil ar-

angement thus avoids many of the difficulties of the traditional ribbon.

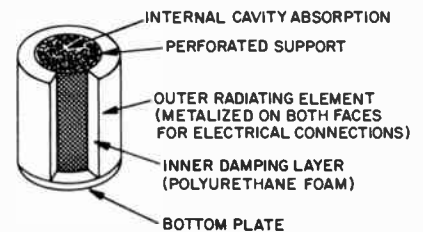
The Piezo-Electric Driver

also called the piezo-ceramic or HPM driver.

The piezo-electric principle is an example of a phenomenon that appears mechanically simple while being extremely complex at the molecular level. In simple terms, piezo-electric substances are materials that move in some fashion when an electric current passes through them (the motion may be in one of two modes; physicists call the two types "twisters" and "benders"; the types of motion are self-explanatory). They include minerals like Rochelle salts, man-made ceramics like barium titanate (used in underwater sound projection, among other



Piezo-electric horn driver element (courtesy Motorola).



Cylindrical high-polymer piezo-electric treble unit (courtesy Pioneer).

things), and some plastics belonging to the same general family as grocery-store meat wrapping, called the polyvinylidene fluorides (meat wrapping, in fact, is slightly piezo-electric, but not enough so for high-fidelity use).

Two firms have done most of the developmental work in piezo-electrics — Motorola, which manufactures a line of OEM treble drivers using thin wafers of ceramic material fastened to cones, and Pioneer, which manufactures a number of speaker drivers using sheets of polyvinylidene fluoride formed into cylindrical shapes, as well as flat headphone drivers, all under the trade name "HPM" (for High Poly-

mer Material). Both types of units have characteristic falling electrical impedances and high mechanical impedances, and are therefore suitable for use at present only in high-frequency applications. The falling reactance, however, is fortuitously usable as a simple internal crossover element, and many of the Motorola drivers used in commercial loudspeaker systems are connected with only a simple power-limiting series resistor. Power handling in both types is fairly high, since there is little heat generated under normal conditions of use (a more common cause of failure under stress, notes a Motorola engineer in one paper, is fracturing of the thin, brittle ceramic elements). The Motorola units find frequent use in high-power disco and sound-reinforcement applications, in fact. On the horizon are wider range units, perhaps in the form of pulsating cylinders or dipolar strip-type arrays.


Exotica

On the outer fringes of the loudspeaker design field are a number of other types, most notably the pricey (\$6500 per pair) and complex Plasmatronics loudspeaker, which employs a midrange-treble driver consisting of an air-helium plasma (plasma in this sense indicating a gaseous substance with an abnormally high number of ions and a consequent charge) that thermally expands and contracts rapidly to produce sound. In the case of the Plasmatronics unit, the plasma is a lavender triangle-shaped mass fed by a high-power tube amplifier, with helium bled into the driver from a tank that must be refilled at regular intervals. The speaker is similar in many ways, according to inventor Alan Hill, to the well-known DuKane Ionovac of the '60s, which at that time was believed to operate on an entirely different principle (a thought-provoking comment on engineering as an art).

Other exotica include arc-discharge ("singing arcs") loudspeakers of the type demonstrated by one high-end amplifier manufacturer at a recent Consumer Electronics Show, although no commercial examples of this format now exist.

As MacLachlan's work aptly indicates, there is little that is truly new under the sun in any mechanical field — loudspeakers included, so most current engineers, including those actively involved in "blue-sky" development projects, don't see much in the way of truly revolutionary introductions over the next several years. Rather, the new age loudspeakers we've discussed will

benefit in an evolutionary way from the availability of new materials and new measurement techniques, perhaps eventually supplanting the moving-coil driver in high fidelity applications. The enormous potential of these new ideas, however, even in their barely developed present state, suggests we have many improvements to look forward to in the coming decade.

Indeed a new age for speaker designers, and for listeners as well. 

Acknowledgement

The drawings used in this article are based on those in Martin Colloms' excellent book *High Performance Loudspeakers*, published by Halsted Press, div. of John Wiley & Sons, 605 Third Ave., New York, N.Y. 10016.

Further Reading on the New Age Loudspeakers

Electrostatics

Electroacoustics, F. V. Hunt, Wiley — The original and to date most complete examination of the electrostatic principle.

"Wide Range Electrostatic Loudspeaker," P. J. Walker, *Wireless World*, May-July, 1955 — Design treatise on the first of the truly practical commercial electrostatic units, the Quad. Fascinating in its coverage of design details, especially because the Quad remains one of the world's best today.

"Full-Range Electrostatic Loudspeakers," H. Leak and A. Sarker, *Wireless World*, October, 1956 — First coverage of the "inside-out" electrostatic.

"A Wide Range Electrostatic Loudspeaker," Charles Malme, *Jour. of the Audio Eng. Soc.*, January, 1959 — Thorough coverage of an interesting electrostatic handmade as a graduate project at M. I. T. out of kitchen and garden parts.

"Electrostatic Loudspeaker Development," Arthur Janszen, *Jour. of the Audio Eng. Soc.*, April, 1955 — Practical examination of electrostatic design problems by one of the giants in the field.

Planar-Dynamics

High Performance Loudspeakers, Martin Colloms, Halsted Press — Comparative evaluation of the various drive mechanisms available to the designer.

"The Isodynamic Principle," G. P. Millward, *Proceedings of the Audio Eng. Soc.*, 50th Convention — Thoroughgoing study of the planar-dynamic principle and its application to headphones, by a Wharfedale engineer.

"Electrodynamic Speaker Has Totally Active Surface," Stanley Rich, *Electronics*, June 16, 1961 — A Bogen three-way system of the early '60s with not only a planar-dynamic midrange and tweeter but also a pneumatically driven bass driver is analyzed by its developer.

"A Novel Planiform Loudspeaker System," R. Whelan, *Proceedings of the Audio Eng. Soc.*, 50th Convention — Coverage of the innovative but ill-fated Strathern wide-range planar-dynamic.

Ribbons

"Tweeter Using New Structure and New Material for Diaphragm (Direct-drive Ribbon Tweeter)," H. Nakajima, et al., *Proceedings of the Audio Eng. Soc.*, 63rd Convention — Sony's ribbon tweeter, which straddles the line between planar-dynamic and ribbon, is discussed.

"Ribbon Velocity Microphones," Harry Olson, *Jour. of the Audio Eng. Soc.*, June, 1970 — The whole principle turned around and studied by one of the pioneers of loudspeaker design.

"Wide-range High-power Tweeter Using the Printed Planar Voice Coil (The Leaf Tweeter)," N. Sakamoto, et al., *Proceedings of the Audio Eng. Soc.*, 58th Convention — Another Japanese ribbon unit covered in detail.

Piezo-Electrics

"Electrostatic Transducer with Piezoelectric High-polymer Film," M. Tamura, et al., *Jour. of the Audio Eng. Soc.*, January, 1975 — Pioneer's design team discusses the chemistry and physics of their HPM drivers.

"A New Type of Tweeter Horn Employing a Piezoelectric Driver," Jonathan Bost, *Jour. of the Audio Eng. Soc.*, October, 1975 — Motorola's piezo-electric drivers are described in detail.

Exotica

"The Ionic Loudspeaker for the Reproduction of High Frequencies," A. Falkus, *British Kinematography Sound & Television Soc.*, Vol. 48, 1966 — A theoretical treatment of the ionic approach.

"The Corona Wind Loudspeaker," G. Shirley, *Jour. of the Audio Eng. Soc.*, Vol. 5, 1957 — Somewhat similar in principle to the above, the title is one of the best teases in technical literature.

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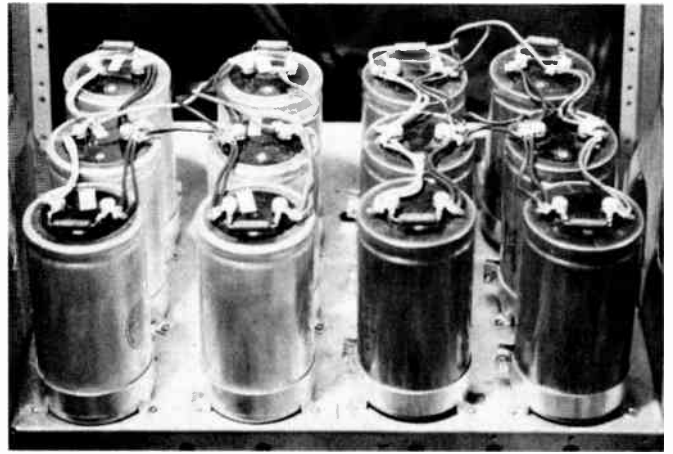
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Build An ENERGY STORAGE BANK

Walter G. Jung



All of us have at one time or another heard of schemes to increase the performance of a stereo amp by augmenting its power supply. The simplest way to do this is to connect additional outboard (or inboard) filter capacitors in parallel with the original internal ones. This increases the electrical capacity and energy storage capability of the power supply, and in many cases dramatically improves the quality of sound reproduced by the amp. The improvements show up in such areas as increased bass separation and reproduction, greater power, and in some cases increased overall clarity and definition — from top to bottom.

If just the simple addition of some additional capacity can be all that is needed to improve the sound, a logical question is why is this not done by the original manufacturer. The best answer is one of cost, as the capacitors involved represent not a small amount of money (even for an OEM), and would probably increase the selling price to undesirable levels. Also, several of these capacitors can take up considerable space, even up to a volume approaching that of the original amplifier package. So, the option of the use of such a high-capacity bank is one very seldom if ever exercised as part of the original design. One exception to this general rule is the Audio Research line of solid-state audio power amplifiers, of which the D110B features a separate, ± 50 V, 300 joule power supply for each channel! As a demonstration of the point on size made above, the D110 weighs 92 lbs. and comes in a 10½ inch high by 17 inch deep rack-mount configuration.

The more typical stereo amplifier power supply is one like that of the Dynaco Stereo 400, which has an energy capability of 56 joules (10,000 μ F of capacitance on each of its 75 V power busses). With the addition of the optional C-100 energy storage system, however, the power supply of the 400 (or that of the 416 or 410) can be increased to a total energy storage rating of 274 joules. Amplifiers with power output capabilities more or less similar to the Dyna 400 also have relatively modest power supplies for their power outputs; examples include the GAS Ampzilla (95 joules), Heath AA-1640 (62 joules), and Southwest Technical's Tigersaurus (49 joules). Note that these amps are not necessarily singled out because of any innate performance characteristic, but rather the fact that all are (or have been) available as home construction projects and thus are more in line with the nature of this article. The general background theory is applicable to virtually any stereo amp for fundamental reasons.

If you should want to evaluate the energy capacity of your present amp, you need to know only the power supply voltages and the capacitance of the filter capacitors. Energy (in joules) is related to this capacitance (C) and voltage (V) as: Energy = $\frac{1}{2}(CV^2)$. Note that this relationship applies to a sin-

gle capacitor, charged to the voltage V. Since most modern amplifiers use bipolar supplies (symmetric voltages) and equal plus and minus filter capacitances, the total energy storage will be the sum of that stored in the plus and minus legs (or simply twice that of a single leg). It is this latter method which was used to calculate the figures quoted above. You might find it interesting to perform such a calculation on your present amp to see how it compares.

The differences that a substantial increase in energy storage capability make in the sound of an amplifier can be perceived in the weight, character, and overall solidity of the sound, most particularly in the bass. Bass reproduction will be experienced as more tight, solid, deep, and controlled. Of course, the exact magnitude of improvement realized also depends upon other system factors, such as, for example, the accompanying speakers. Thus it would be rather pointless to go to the trouble of building a high-energy storage bank for an amp and listen to it on bookshelf speakers which roll off at 100 Hz. Therefore, we assume in this discussion that if you are after the highest performance in these areas, you will act accordingly in other areas as well.

An important point which should be made is that a truly high-performance filter bank can make substantial audible differences throughout the frequency spectrum. While the increased current available from the higher energy storage bank can dramatically increase drive capability, particularly with lower impedance loads, there is substantial broadband improvement potential also. This is because the increased capacitance in the supply also lowers the effective series resistance, R_s (also called ESR, for equivalent series resistance). This, in turn, reduces mid- to high-frequency crosstalk and noise components, which tend to clean up reproduction. Exactly how much of this type of improvement is to be realized is dependent to a degree upon the specific amplifier circuit topology used, so it is difficult to say just how much it will be apparent in a given amp. Evidence of this factor at work will be increased definition, more precise and stable instrument location, and a generally more alive sound, particularly with reproduction of sharp transients.

Building a Filter Bank

All of the above might sound very inviting to the home constructor, as it tends to imply sonic benefits merely for the price of some extra capacitance. But like the old adage "there is no such thing as a free lunch," you do pay for these benefits, and do so in several ways. First of all, you will pay in terms of the space to safely house the extra capacitance. Second, there is the cost of the bank and its associated hardware, which will run in the neighborhood of \$50 to \$100,

even if you buy the caps surplus and do all the work yourself.

Third, there are *very important safety considerations* to be dealt with in both the building and maintaining of a filter bank. It goes without saying that the reader is responsible to himself to guarantee the safe assembly and operation of these filter banks, and prudent precautions should obviously be taken. Be forewarned — **this is a project for the advanced experimenter only and not the novice.** You construct the circuitry described here at your own risk, and we cannot be responsible for accident, injury incurred, or damage to your amp and/or peripheral gear!

A typical stereo amp power supply is shown in Fig. 1, and arrangements very similar to this can be found in amps of the 100 to 200 watt per channel class. Amps of 80 watts run around ± 40 to 50 V of supply voltage, while those with 200 watts or more of power run ± 70 to 80 V supplies. The procedure we will describe is applicable to either, the only differ-

ence being in the appropriate capacitors. The banks described can be built with either 50 V or 75 V (standard rating) capacitors, as is suitable to your particular amp. If the voltage rating is in doubt, just read the voltage rating of the units used in your amp. You should match or exceed this voltage rating with those to be outboarded. The original capacitors will most likely be in the range of 10,000 to 20,000 μF each, one for plus and one for minus. The external storage bank will (desirably) increase this capacitance by a factor of five or more, proportionally increasing energy storage and decreasing power-supply buss impedance.

The external bank is connected electrically in parallel with the internal capacitors via a three-pin locking female connector. Note that this connector *must* be a locking or threaded coupling type, to prevent accidental disengagement with power on. An external filter bank with a high-energy capacity, such as described here, should never be connected to the

Test Procedures

1) Inspect capacitor(s) for physical condition before testing. Check to see that the gasket or seal (vent) is intact and capacitor has not vented. Caution—*all* quality capacitors of this type will be constructed with a venting mechanism, which is for the safe release of internal pressure (in the case of a fault), in lieu of a possible explosion. *Do not* use any capacitor which is not equipped with a venting mechanism—this is for your own safety!

Check also for broken lugs, case dents, intact insulating sleeve, and any other obvious physical defects. Use no capacitors which are not absolutely problem-free in these regards.

2) Capacitor to be tested is connected in the setup as shown. Make sure that the polarity of voltage applied is absolutely correct, the series resistance R_s is in the circuit, and the voltage applied is appropriate. If you don't have a bench supply for this test, you can "steal" the voltage from your amp, if necessary.

Arrange the capacitor under test so that if it were to vent, the gases escaping would be safely contained. It would be wise to clamp it (with a standard mounting clamp) to a firm surface, and place an inverted heavy-wall plastic bucket over it, with a weight on top of the bucket.

3) With the capacitor physically and electrically so connected, turn on the power supply and monitor I with the DVM (note: 1 V = 1 mA for this position). Current should start high, and diminish slowly as the capacitor charges, and then forms to the applied voltage. Current should ultimately drop to 1 mA or less, when the unit is fully formed. Be wary of units with high leakage (>5 mA). Allow about 15 minutes of time for formation for each year of shelf storage (see date code of unit), if needed. After test is complete, turn off supply, allow capacitor to discharge to 1 V or less, and remove from setup. Do not allow capacitor to sit in an open state, but clip a 100-ohm, 2-W resistor across its terminals. This will prevent voltage buildup, due to dielectric absorption.

4) Repeat steps 1 to 3 for each capacitor to be used in the bank under construction until a sufficient number have been qualified. They may then be wired into the bank as described in the text of this article,

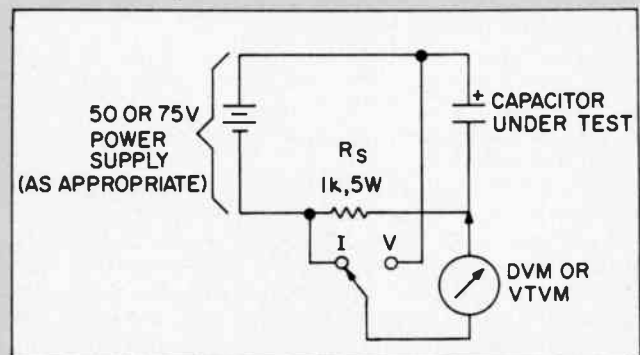
with their bleeder resistors. When the bank is wired and complete, it is wise to repeat the leakage current test of step 3 for each plus and minus filter bank leg considered as a single capacitor. For this check place the capacitors in their housing and temporarily lift off the bleeders to make the leakage check.

Note that when a 1-kilohm charging resistance is in use, it will take quite some time (15 minutes) to fully charge 100,000 μF , so don't confuse charging current with leakage. If you would like to speed up the measurement, you can change the 1000-ohm resistor to 100 ohms for this test. Allow about 10 time constants before you measure leakage (20 minutes for $R_s = 1$ k; 2 minutes for $R_s = 100$ ohms). Leakage should be no more than 5 mA for the bank, or 1 mA times the number of caps in use, in general. Reconnect the bleeder resistors (carefully!) after this test.

Repeat leakage tests for both plus and minus legs; when all is finished and OK, make sure that all bleeder resistors are in place and all connections are secure.

5) As a final check, make absolutely certain that the connector wiring of both the bank and amp is proper. A polarity reversal here would be disastrous (so don't skip this step); also make sure the clamp diodes are in place and secure.

Setup for testing computer-grade electrolytic capacitors for filter bank use. Note: See Test Procedures for precautions!



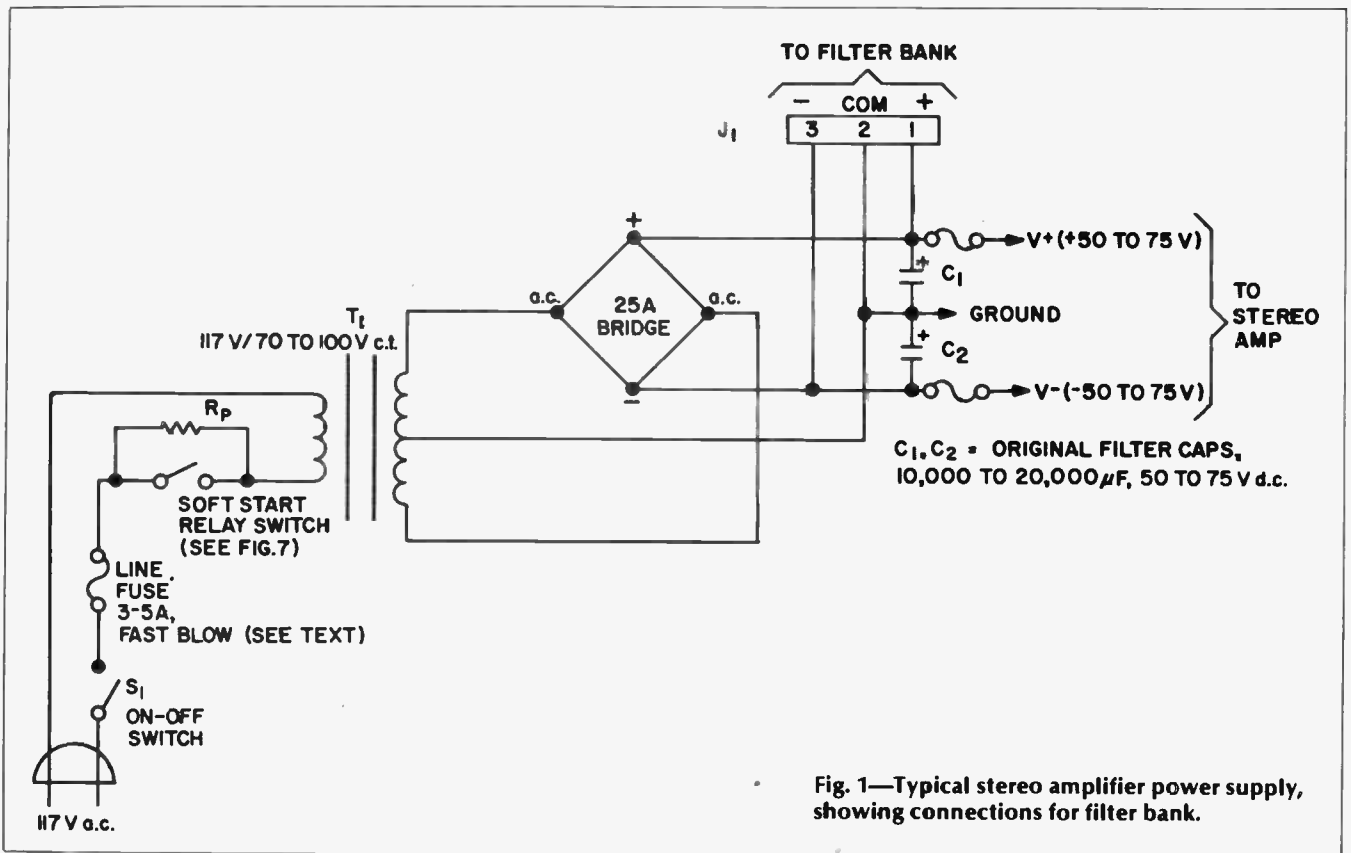


Fig. 1—Typical stereo amplifier power supply, showing connections for filter bank.

amp live or with power on the amp. If this were to be done, the contacts of the connector would very likely fuse and the bridge rectifier be blown, due to the very high current surge which would result.

The high charging current surge of a bank of 100,000 μF or so of capacitors presents a very real problem in turning on the amp and getting the voltages up to operating level safely. This is simply because the very low impedance presented to the transformer secondary by the high capacitance will result in rectifier and capacitor surge currents in the hundreds of amperes, if not limited by positive means. Similarly, the transformer primary current will also reach catastrophic levels, easily sufficient to weld switch contacts and blow both fuses and circuit breakers.

For these reasons, a soft-start delay switch must be used to prevent excessive turn-on surges. This can be as simple as a primary series power resistor, which is shorted after a sufficient interval by a time-delay relay. The shorting switch contacts must, of course, be capable of carrying high a.c. currents, such as 10 A or more (to prevent excessive power loss). This scheme is shown in simplified form in Fig. 1, and is discussed in more detail later.

The schematic of a typical filter bank is shown in Fig. 2. Here C_1 and C_2 are electrically in parallel with the original C_1 and C_2 of Fig. 1. C_1 and C_2 are made up of sections C_{1A} , C_{1B} , etc., with individual capacitors paralleled to get the total capacitance desired.

C_1 and C_2 are listed as 20,000 $\mu\text{F}/50\text{V}$ or 10,000 $\mu\text{F}/75\text{V}$ units, but this is just a general guideline. In the size specified for the chassis used, these two ratings match up generally with the case size of 3 inch diameter by 5.6 inch high. You can, of course, use any other smaller size, but the 3 inch (largest standard diameter) maximizes capacitance and will minimize the number of cans required. Some specific units which have been used in filter banks are shown in Fig. 3;

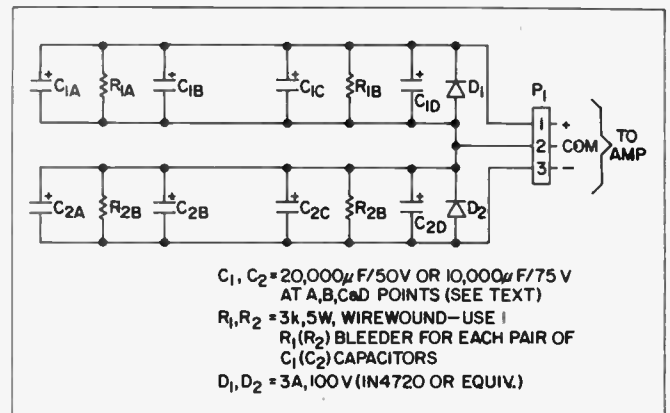


Fig. 2—Connection diagram of outboard capacitor filter bank.

their ratings are generally what is desired to build a bank such as this. Detailed selection information can be found in the Jung/Marsh general article on capacitors [3].

Most home constructors will want to use surplus units in this project to save money, but understand that you may be somewhat limited as to what is available. As a comparative cost estimate, a single one of these capacitors will cost \$20 to \$25 new, but they can be obtained for below \$10 on the surplus market. The catch is that **surplus units must be pre-tested for leakage and reformed to the intended operating voltage**. This process, while time consuming, is not overly difficult and is described in detail in the sidebar. Take caution — such testing must *not* be omitted if surplus caps are used. If you use surplus units and discover defects in these



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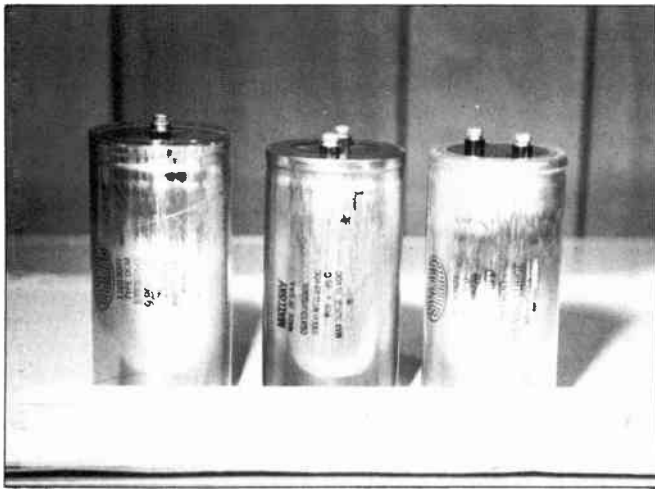


Fig. 3—Typical electrolytic capacitors used in filter banks. Photo by Charles Hollander.

tests, a reputable dealer should readily exchange any damaged unit. If there is any question on this point, make sure of the dealer's position before you make the purchase. (A listing of several sources accompanies this article.)

A large capacity bank such as this represents considerable energy and voltage, and is *potentially lethal*. A number of safety points should be made. A well-derated wire-wound bleeder power resistor is a must and, for further safety, is recommended for every two capacitors used. Using bleeder resistors redundantly like this will ensure discharge of the bank, even in the event that one of them should fail. By all means, use the bleeders, and physically locate them on the filter caps, even though the amp itself will bleed off the charge when connected. The bleeders are for your safety, if and when you work on the bank.

Diodes D1 and D2 are reverse-voltage-catch diodes, to limit any possible voltage applied to the bank in reverse. They should have a high surge-current capability, such as the 1N4720s specified, which are rated for a 300 A surge. Alternatively, a 100 V, 25 A bridge can be wired for this function. Any reverse voltage on the filter bank capacitors must be kept to an absolute minimum (below 1.5 V), since under such conditions it is possible for these capacitors to fail, and in extreme instances even explode. Never underestimate the power of Murphy's law when it comes to safety considerations.

Physically, the bank is wired as shown in Fig. 4, a top view of a dual six-capacitor filter bank constructed for a pair of mono-connected stereo amps. Although it may not be obvious from this photo, one set of these two banks uses 25,000 μ F/50 V (from Fig. 3,) while the other uses the 33,000 μ F/50 V units. Each plus and minus section uses three caps, so they both total about 100,000 μ F or more for the plus and minus legs. Note that electrolytic caps such as these will typically measure higher than their stamped rating; for the units here they measured about 20 percent higher. Note the paralleled wiring busses, which use heavy gauge (#14) stranded wire.

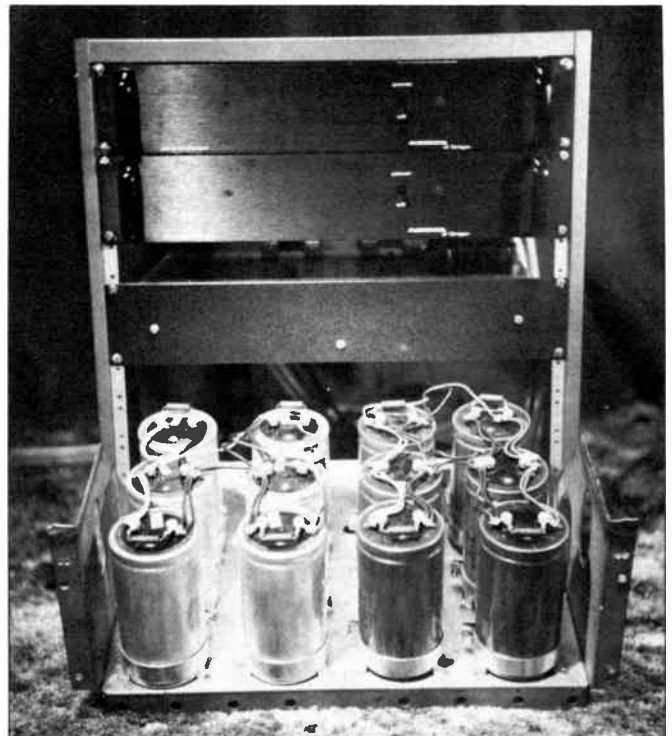
There may be some question as to how many capacitors are necessary or sufficient to achieve the results described above. Generally, you can hear differences with each step increase in filter capacity. With the filter bank of Fig. 4, for example, a single capacitor pair was first tried (with success), then the jump was made to three pairs with even greater results. The question arises, where do you stop? The answer to this just has to be one of practicality. It appears that once you get beyond 100,000 μ F per side for a 50 V bank, further

"capacitor pair" increases become more subtle, and it would take perhaps another 100,000 μ F per side (200,000 μ F total) to make a really dramatic difference. And certainly, at these levels and relative impedances, *many other factors can be limitations*. For example, if an external capacitor bank is constructed which results in a net R_s (or ESR) of 5 milliohms right at the terminals, it will generally only be possible to approach this low level of impedance back at the amplifier end of the connecting cable. Number 14 wire, for example, has a d.c. resistance of approximately 2.6 milliohms per foot, therefore a one-foot cable (probably near the shortest general limit for practicality) will be about equal in impedance for the two-way path. To this 5.2-milliohm impedance must be added the contact resistance of the connector and the wiring internal to the amplifier, between the connector and the original capacitors. In addition, the inductance of these wires serves to decouple the external capacitors even further at high frequencies; this is beyond the capacitor's inherent self-inductance, as outlined in [3].

The bottom line of this commentary is that, from an effectiveness standpoint, the best electrical (and physical) location of the extra capacitance is really *within* the amplifier, as close as feasible to the original capacitors. For both the electrical and safety reasons, it behooves the audiophile to augment power supply capacitance in this manner, if it is at all possible. (Also, an internal pair of film capacitor shunts will be useful, such as the 5- μ F polypropylenes mentioned in [3].)

The electrical evidence for this is demonstrated by measurements on the two filter banks of Fig. 4, which are somewhat dissimilar in rating. Bank A has a capacitance of 100,000 μ F per side, and an R_s of approximately 4 milliohms measured directly at the cable attachment point. Through an 8-inch length of #14 wire (paired) and a connector, R_s is

Fig. 4—Two filter banks, one using surplus capacitors, and one using new capacitors. Photo by Charles Hollander.





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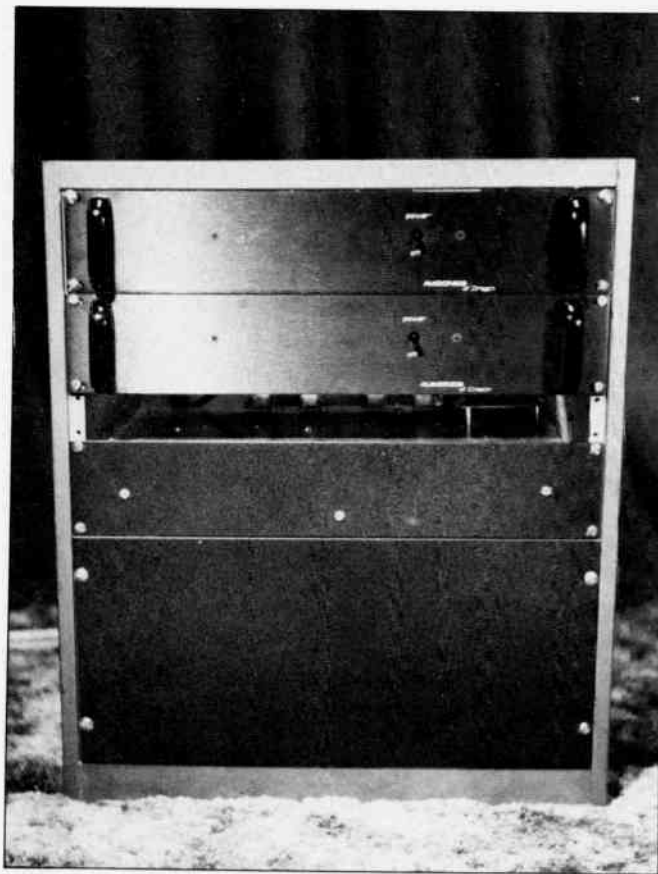


Fig. 5—The two banks of Fig. 4 installed in a surplus 19-inch rack-mount steel chassis. Photo by Charles Hollander.

7.5 milliohms (these impedances are at 1 kHz). At 100 kHz, the impedance at the capacitor terminals is 16 milliohms, but it becomes 150 milliohms at the connector, due to the wire's 0.2 μ H inductance. Bank B has a slightly higher capacitance, but the units used also have higher Rs. As a result, the Rs at the bank measures 5 milliohms, but at the connector it is raised to 13 milliohms (due to a longer 19.5-inch cable). Both the capacitor types used in these banks were general-purpose computer-grade units not specifically designed for low Rs or self-inductance. Their individual unit performance was documented in [3], Fig. 7, units H and I (for banks A and B, respectively).

Recent developments in electrolytic capacitor technology have resulted in the introduction of a large number of high-performance types, with very low values for both Rs and series inductance. If one had complete freedom of choice in choosing power supply capacitance (with Rs and inductance as key parameters), one of these more modern types in a comparable capacitance rating would be highly desirable. Unfortunately, they are not as yet available to the home constructor to any degree and are still relatively expensive special-order items. Thus, the scope of this article is addressed to the more readily available types. Information on the premium electrolytics, however, can be obtained from the manufacturers listed in [3]; ask specifically for low Rs (or low ESR), low-inductance types. (Examples of such series are the Sangamo 139R and the Sprague 622D.)

It is hoped that a future article can explore application of the very high performance electrolytics within amplifier circuits. For the present, the techniques generally described

here are still applicable and useful. But as alluded to above, the exact degree of potential audible benefit with a given amplifier is strongly dependent upon its specific circuitry and the general quality of the original capacitances used. In other words, some amps may show substantial improvement with power supply augmentation, while others may not. The purpose of this article is to show relatively inexpensive and simple methods of upgrading power supply performance. It in no way is being presented as a cure-all solution to audible ills, nor should it be interpreted to imply that it removes the necessity to fix other possible problems.

For the two banks shown in Fig. 4, it was noted that there was little audible difference between the two (on the same amp) with a relatively long cable. However, the shorter cable mentioned above appeared to yield definite improvement with regard to transient reproduction and, where feasible, it is recommended. It is, of course, also sensible to use the shorter cable where possible, because of the objective differences noted above.

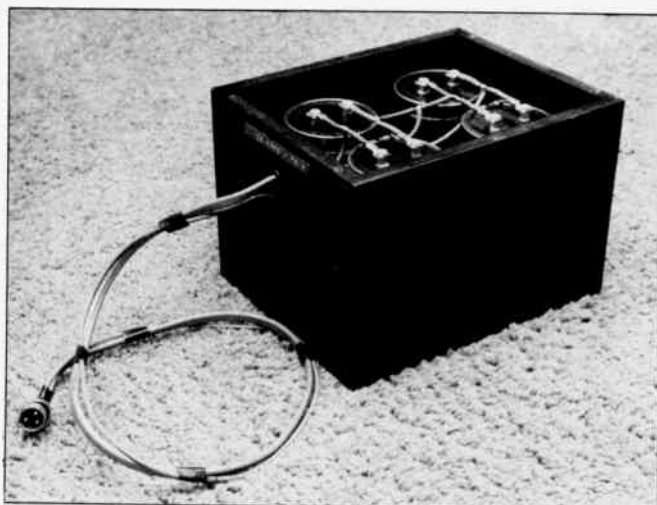
Interestingly, bank A was constructed with surplus caps while bank B used brand-new, factory-fresh capacitors. This shows that if carefully tested and selected, surplus caps can do a job here.

The two banks shown in Fig. 4 were assembled on a surplus steel TV chassis, which in turn is mounted in a 19-inch rack with an 8 $\frac{3}{4}$ -inch steel panel. The arrangement used is shown in the photo of Fig. 5, where the capacitor banks occupy the large bottom panel. The two upper 3 $\frac{1}{2}$ -inch panels are occupied by the two amps which use the caps, a pair of Audionics CC-2s. The intermediate chassis directly above the filter bank houses a.c. power relays and crossover components.

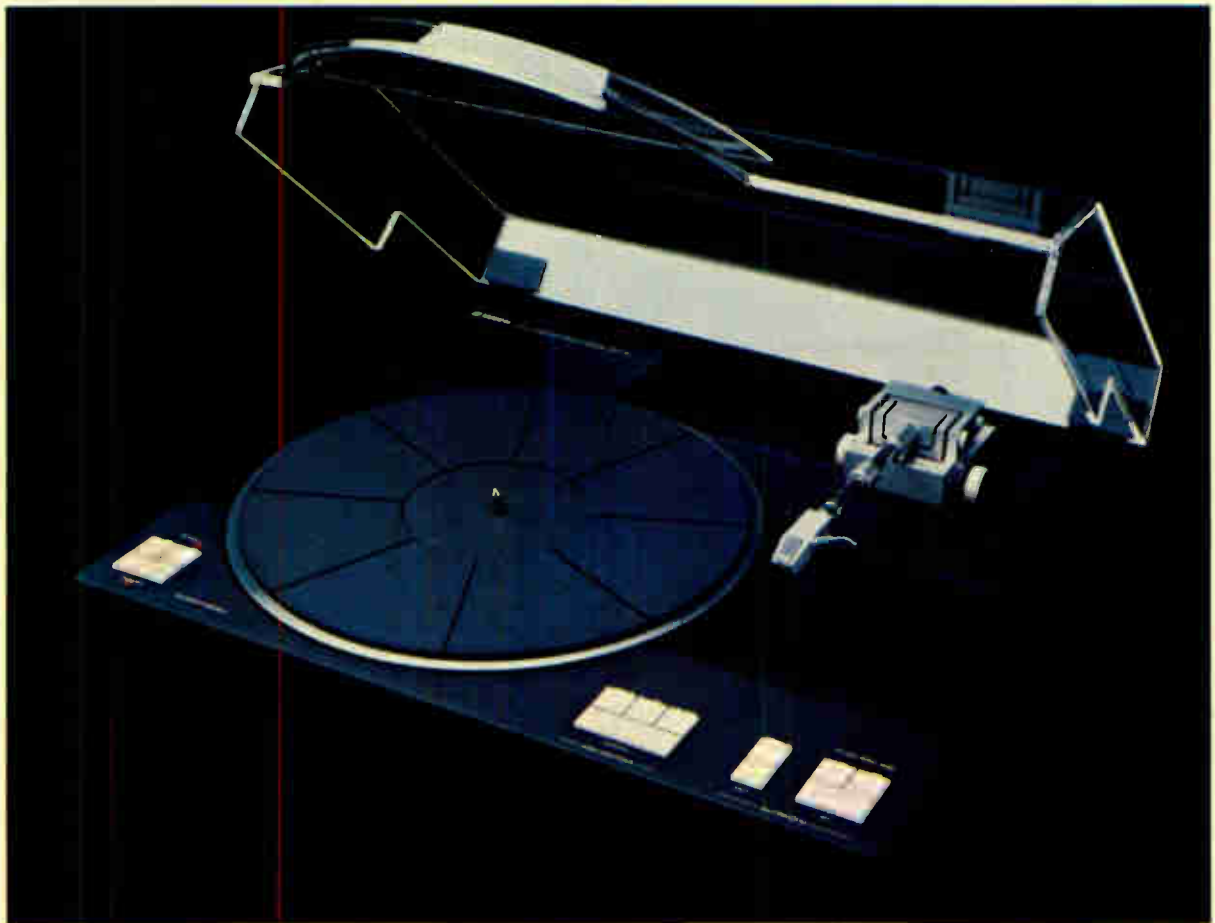
In the above arrangement the filter bank is open on only one side, the rear of the rack. Even this limited access is generally not recommended for safety reasons, and is shown here for information only. Such a filter bank chassis is in general best housed in a totally enclosed rack, and should be appropriately labeled with "Dangerous Voltage" signs, clearly visible with the door open. It is also preferable to have the power interlocked to shut down on the door's opening, with a relay to discharge the bank rapidly.

Not only is an accessible filter bank unsafe for prying fingers (such as those of children), but the capacitors should also be enclosed in case they should vent and spray nasty

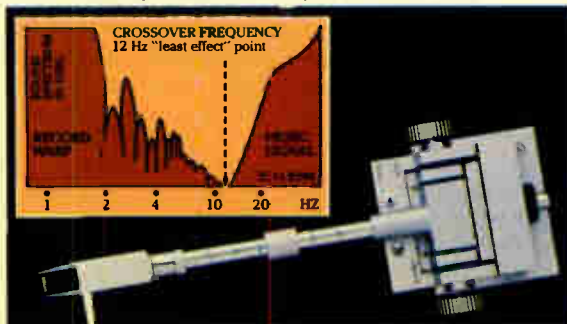
Fig. 6—A single filter bank installed in a steel utility cabinet. Photo by Mark Frautschi.



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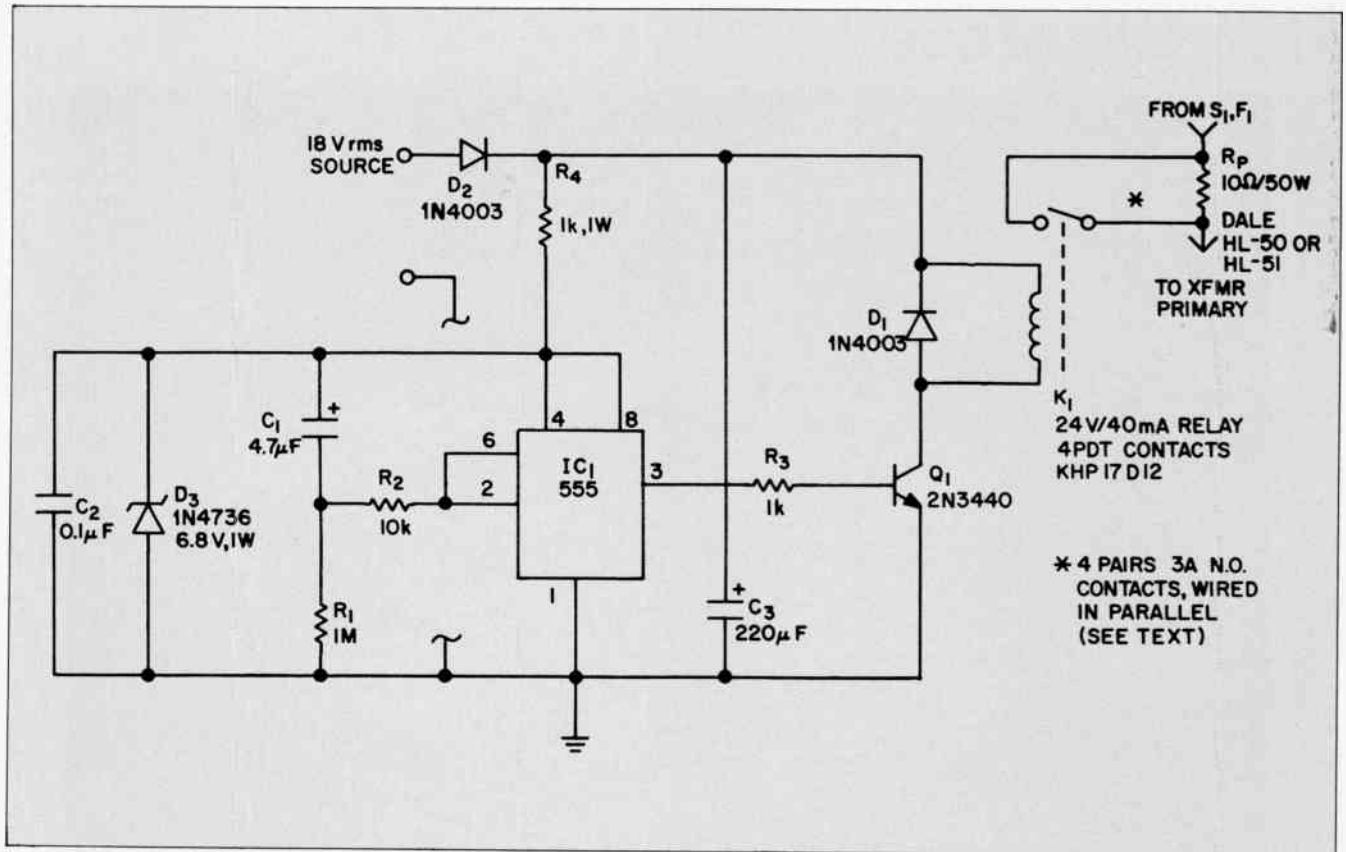


Fig. 7—Automatic soft-start circuit.

juices outward. For these reasons, an enclosed steel box is a more reasonable (and inexpensive) enclosure, with a single large, well-insulated grommet to exit the umbilical cable to the amp. Such an arrangement is entirely satisfactory for single banks, and an example is shown in Fig. 6, a photo of a completed bank installed in a steel utility cabinet. This particular box (Bud CU-879) can accommodate up to four capacitors of the size mentioned; a larger size (Bud CU-880) can accommodate up to six. The particular bank shown here employs four 17,000 μ F/75 V capacitors and is suitable for amps with \pm 75 V (or less) supplies. Parts used in its construction are listed in the parts list for those who wish to scratch duplicate it. Alternatively, single bank units such as this using new 50 or 75 V capacitors can be purchased from Taylor House, Box 140, Denver, N.C. 28037 (704/483-5730).

Other audio dealers who perform modification services similar to these include Audio Dimensions, Inc., 8888 Clairemont Mesa Blvd., San Diego, Calif. 92123 (714/278-3310), and Jensen's Stereo Shop, 2202 River Hills Drive, Burnsville, Minn. 55337 (612/890-3517). The reader should also consult the classified pages of this magazine for others offering similar services. Some modification dealers stock and sell filter capacitors individually, and they may also offer other modification services. Inquire direct on these and other details, mentioning this article.

The Soft-Start Function

Finally, before activating your completed filter bank, you should install some sort of soft-start, delayed turn-on mechanism. It is recommended that the surge limiting impedance to accomplish this be placed in the transformer primary. The impedance of relay contacts in series with the filter bank can

be made to safely control surges, but their added impedance at this point is not as desirable as in the primary of the transformer, which only requires one series resistor (R_p).

The most simple means would be to install a manually operated switch which would allow the series resistance to be included in one *On* position, and then shorted out after a safe interval. Dynaco 400 and Ampzilla amps will allow this to be done, as they have such a switch. However, such an arrangement is not "goof proof" and sooner or later the switch will be turned on without the surge resistor. For this reason, an automatic cycle circuit is recommended. An important criterion for this type of circuit when used with such a large filter bank is that it be fail safe, in several regards. Surge resistor R_p should be wired *after* the line fuse, so that it cannot possibly see a sustained full-line voltage (as shown in Fig. 1).

Also, in regard to normal operation, the circuit should be self-resetting in the instance of temporary line outages, such as during an electrical storm. The circuit described here has this feature, although not all delay circuits do. One example is thermal delay type of relay, which is therefore not an optimum choice for this use.

A scheme similar to the one I used is shown in Fig. 7. This is a 555 delay circuit energized by an auxiliary 24 V supply, which closes the relay K1 after a five-second delay. A readily available 24 V surplus relay is used, and the remaining components are relatively noncritical. Delay time can be trimmed by adjusting R_1 (or C_1 if desired); the time delay equals $1.1 R_1 C_1$.

This circuit can be mounted on a small card and incorporated into the amp itself. Allow for adequate dissipation in R_4 and an adequate voltage rating for C_3 . Note that the d.c.

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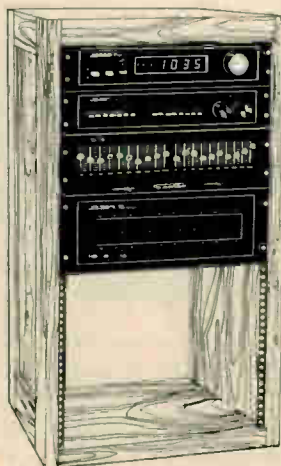
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supply level for this circuit is a *lightly filtered* half-wave source (D2), so as to cause K1 to drop out quickly, for reset upon power loss. Rp is a large, chassis-mounted type which should be clamped securely to the amplifier interior. Make absolutely sure that this resistor is wired *after* the line fuse, so that in the event of a malfunction it cannot see a sustained full-line voltage. The line fuse should be a fast-blow type, selected for just adequate current to carry sustained amplifier outputs. Alternate soft-start schemes have been described, such as those mentioned in [6].

Conclusion

As a final caution, it is appropriate to reiterate that building a filter bank, while simple in basic concept, is *not* a project for the novice. If you are in doubt as to whether you could handle such a project, we recommend you discuss it with one of the dealers.

With the filter bank completely assembled and operating properly in conjunction with your amplifier, some changes in your listening habits will be necessary, out of safety. First of all, be aware that an amplifier modified as described above is capable of very high power outputs for brief periods, because of the energy storage.

You will find that the amp will play for several minutes or so after turnoff, because of the filter bank. *Be aware of this factor when changing inputs or you may pop a speaker.* A good safety feature to prevent this is an input muting switch that can be flipped to short both inputs to ground, and

Parts List

Single or Dual Bank

Capacitor, computer grade, 3 inch diameter x 5 inch high can size, #10 screw terminals, insulated jacket. 50 V: 20,000 to 30,000 μ F @ 50 V—Sangamo "500."

75 V: 10,000 to 20,000 μ F @ 75 V—Mallory "CG," Sprague "36D."

P1: Connector, male, 3 contact, locking type—Amphenol 91-MC3M.

J1: Connector, female, 3 contact, locking type—Amphenol 91-PC3F.

Wire: #14 stranded (3 colors, approx. 6 feet each)—Belden 8584.

Clamps: 3 inch diameter size (1 per cap)—Sprague 4586-2 or Mallory VR12.

Hardware: 6-32 x $\frac{3}{8}$ bolts, nuts, lockwasher (3 per cap).

Solder lug: #10 internal tooth (3 per cap).

Resistor: 3 k, 5 W, wire-wound, axial lead (0.5 per capacitor).

Single Bank, Similar to Fig. 6

Cabinet—Bud CU-879 (4 caps) with black wrinkle finish or CU-880 (6 caps); $\frac{1}{2}$ inch ID rubber grommet (1); rubber feet, Bud 9411 (4).

Dual Bank, Similar to Fig. 4


Relay rack panel: $8\frac{3}{4}$ inch high, steel, black—Bud PS-1254 BR.

Chassis mounting brackets: $8\frac{1}{2}$ inch high, steel, black, 13 inch depth—Bud MB-451.

Chassis: 13 inch x 17 inch x 2 inch, 18 gauge steel, black (see text)—Bud CB-659.

Cabinet rack: $8\frac{3}{4}$ inch, steel—Bud CR-1741.

thereby allow cables to be changed readily. (This is true, by the way, for any high-power amp, regardless of whether a filter bank is used.) If you do not incorporate a muting switch, always play the amp down to zero volume with an active input so that a preamp with switch-off transients will not vaporize your speakers.

Heed all of the above precautions, construct (and use) your filter bank safely, and I think you will then be rewarded with much more enjoyable musical pleasure! 

Acknowledgements

I'd like to thank Bill Elias of Sangamo Capacitors for helpful comments on this article. Thanks also go to Dick Marsh, Dave White, Jim Boak, and Rod Rees for their helpful comments and criticisms.

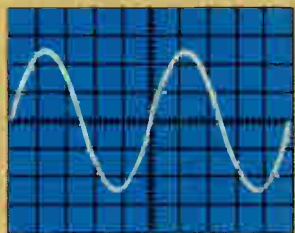
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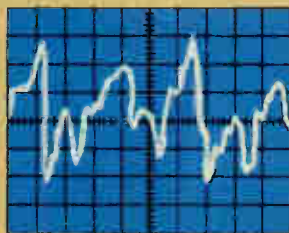
Many amps can deliver pure sound. The Sansui AU-919 delivers pure music.



Today's audio engineering has reached the point where you can select among a number of affordable high-power amplifiers that have virtually no "total harmonic distortion." That's good. But THD measurements only indicate an amplifier's response to a pure, continuously repeating, steady-state test signal (below, left). They don't tell you how the amp responds to the never-repeating, rapidly-changing transient waveforms of real music (below, right). And only an amplifier designed to reproduce the demanding dynamics of music signals can satisfy the critical audiophile. An amp like the Sansui AU-919.



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Equipment profiles

Mitsubishi DA-R20 Receiver



Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 9.3 dBf (1.6 μ V).

50-dB Quieting Sensitivity: Mono, 15.0 dBf (3.0 μ V); stereo, 36.8 dBf (38 μ V).

AM Suppression: 60 dB.

Capture Ratio: 1.5 dB

Image Rejection: 85 dB.

I.f. and Spurious Rejection: 100 dB.

Selectivity: Wide, 60 dB; narrow, 75 dB.

S/N: Mono, 84 dB; stereo, 80 dB.

THD, Wide I.f. Position: Mono, 0.08 percent at 1 kHz; stereo, 0.1 percent.

THD, Narrow I.f. Position: Mono, 0.15 percent at 1 kHz; stereo, 0.2 percent.

Sub-Carrier Rejection: 60 dB.

Stereo Separation: Wide, 46 dB at 1 kHz, 42 dB at 100 Hz, and 43 dB at 10 kHz; narrow, 40 dB at 1 kHz, 36 dB at 100 Hz, and 40 dB at 10 kHz.

Frequency Response: 30 Hz to 16 kHz, +0.5, -1.0 dB.

AM Tuner Section

Usable Sensitivity: 300 μ V/m with internal antenna.

Selectivity: 30 dB.

S/N: 52 dB.

Image Rejection: 47 dB.

I.f. Rejection: 35 dB.

THD: 0.5 percent.

Amplifier Section

Power Output: 60 watts per channel, 8 ohms, 20 Hz to 20 kHz, 0.02 percent THD.

Dynamic Headroom: 1.0 dB.

Damping Factor: 120.

Slew Rate: 50 V/ μ S.

Phono Input Sensitivity: MC, 100 μ V; MM, 2.5 mV.

High Level Input Sensitivity: 150 mV.
Maximum Phono Input: MC, 7 mV; MM, 140 mV.

Frequency Response: Phono, RIAA, \pm 0.3 dB; high level, d.c. to 100 kHz, -2.0 dB.

Rated IMD: 0.02 percent.

S/N (New IHF): Phono MC, 78 dB; MM, 85 dB; high level, 87 dB.

Bass and Treble Control Range: \pm 10 dB at 100 Hz and 10 kHz.

Low Filter: 12 dB/octave below 18 Hz.

High Filter: 12 dB/octave above 10 kHz.

General Specifications

Dimensions: 18½ in. (46.25 cm) W x 6½ in. (16.56 cm) H x 16¼ in. (40.31 cm) D.

Weight: 31 lbs. (14.09 kg).

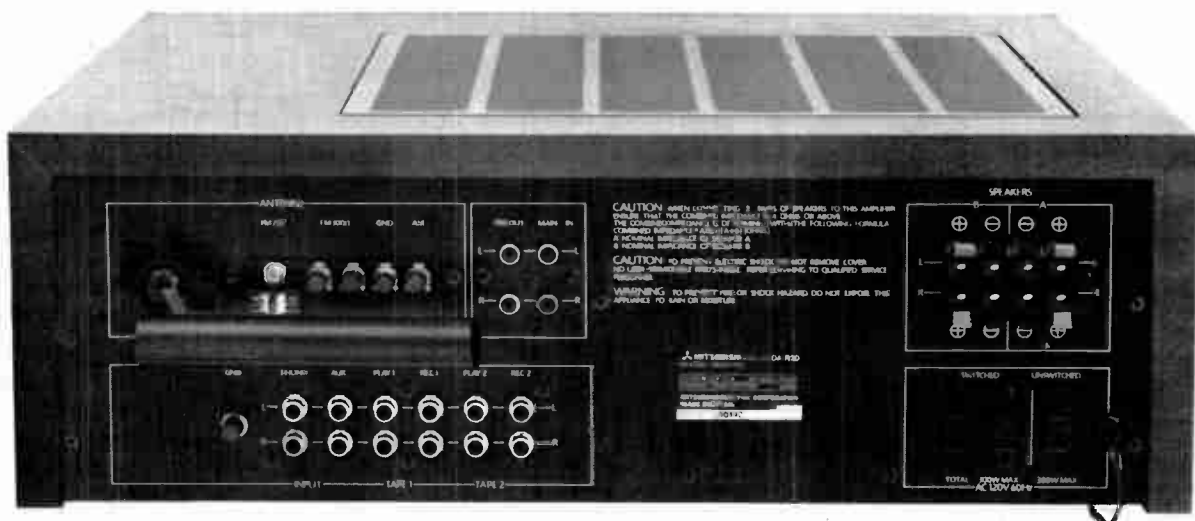
Price: \$560.00.

It has been some time since I had an opportunity to evaluate a piece of Mitsubishi high-fidelity componentry, the last encounter having been with their uniquely configured DA-F10 tuner-preamplifier several years ago. Much of what I admired at that time has been incorporated into Mitsubishi's first receiver entry for the U.S., plus a great deal of innovation brought about by the passage of time and the advancement of the audio art.

The tuning dial mechanism, carried over from the earlier successful design, employs a rotary dial which, in a small amount of panel space, provides extremely fine vernier tuning action; fully 15 turns of the flywheel-coupled knob are

needed to get from one end of the FM band to the other. Frequency markings here are delineated in 1-MHz increments since nearby, at panel-center, is a four-digit fluorescent frequency read-out which reads FM or AM frequencies, the former to the nearest 100 kHz, the latter to the nearest kHz. Why the two forms of read-out? As far as we could tell, basically for the ease of reading the digital display.

The tuner section has a form of AFC locking system, now quite commonly found on better tuners and receivers, and this lock circuit's operation is indicated by a small light in the area of the rotary dial. Another indicator in this region of the panel is the stereo light.



Controls along the lower section of the front panel include a power on/off push button at the left, slim rectangular push buttons for speakers "A" or "B," stereo/mono mode selection, and low- and high-cut filters. Below this bank of buttons are the step-type bass and treble tone controls, with a tone-defeat push button located between them. Next are separate *Record Selector* and *Program Selector* switches which permit the user to record any program source onto tape while listening to any other program source. Tape dubbing (tape 1 to tape 2 or vice versa) is also accomplished by means of the *Record Selector* switch. While the *Program Selector* switch has only one phono setting, a nearby slim push button chooses moving-coil or moving-magnet operation of the associated phono input jacks on the rear panel. Below the selector switches are a *Balance* control and a *Loudness* control, which last operates completely independently of the large master volume control just to its right. The master volume control is arbitrarily calibrated from 0 to 10 for easy resetting.

Additional push buttons located between the master volume control and the *Tuning* knob include a high-blend switch (for reduced noise during weak-signal stereo FM reception), an i.f. band switch with wide and narrow settings, a combination mute/mode switch (muting off/mono on, or muting on/auto on), and an AM/FM band selector. As with many other tuners and receivers of recent vintage, the combining of the mute on/off and the mono/stereo FM selection into a single switch does prevent the diehard FM dx-er from trying to listen to weak-signal stereo reception in stereo, and for this reason we have objected to this cost-cutting approach in the past. From a practical point of view, however, few users would be inclined to listen to stereo FM at the noisy background levels at which this tuner section's muting circuitry is likely to block reception, so I no longer feel as strongly about this slight compromise in flexibility of controls.

The rear panel of the DA-R20 is equipped with the usual 75-ohm, 300-ohm, and AM external antenna terminals, a pivotable built-in ferrite-bar AM antenna and, below the antenna section of the panel, the required phono, high-level and tape-input pairs of jacks, as well as the tape-out jacks plus a chassis ground terminal. Preamp-out and main-amp input jacks are located nearby and require neither a set of jumper cables nor a switch for interrupting circuitry when separate access to these two sections of the receiver is required. Instead, Mitsubishi has used a clever type of main-amp in jack which open-circuits the signal path whenever a phono plug is inserted into it.

Well isolated from the input region, at the opposite end of the rear panel, are two sets of color-coded, spring-activated speaker terminals for main and remote speaker pair connection and one unswitched and two switched a.c. convenience receptacles for connection of other component power cords. There are no replacement fuse holders or circuit breakers on the rear surface of the unit.

Circuitry

Among the major design elements and circuit features of the Mitsubishi DA-R20 are the use of a dual-gate FET r.f. amplifier and a dual-gate FET mixer, plus improved group delay ceramic filters in the i.f. section. The PLL multiplex circuitry used in the FM stereo decoder section also employs a pilot canceller circuit for reduced sub-carrier output products. The wide and narrow i.f. selectivity characteristics of the FM tuner section are achieved through the use of separate i.f. stages, each of which is equipped with appropriate ceramic filters. The quadrature detector circuit employs a transformer-type quadrature tuning circuit for increased linearity and bandwidth.

In the audio section, a separate pre-preamp is incorporated for direct use of moving-coil cartridges and is followed by a

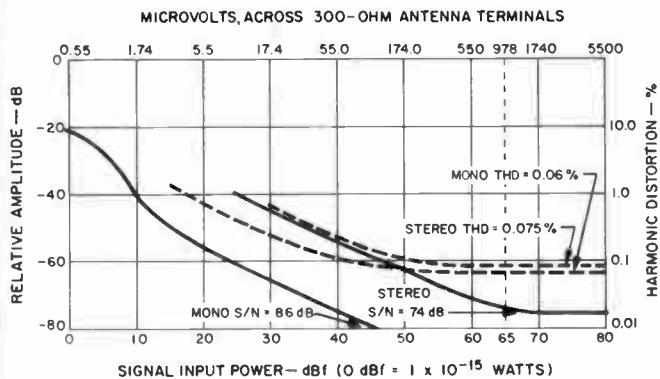


Fig. 1 — Mono and stereo quieting and distortion characteristics, FM section, wide bandwidth setting.

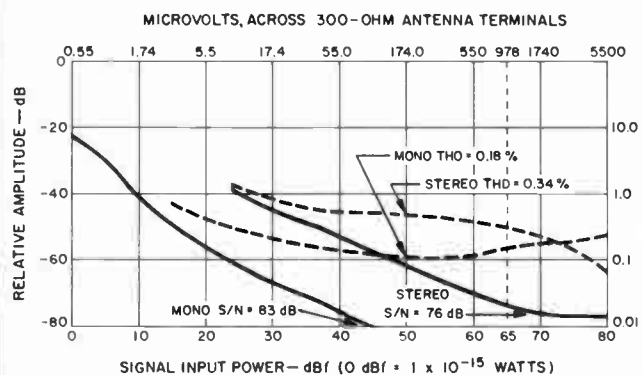


Fig. 2 — Mono and stereo quieting and distortion characteristics, FM section, narrow bandwidth setting.

narrow mode selectivity increased to 75 dB as claimed. By not reducing selectivity too much in the wide setting, Mitsubishi was able to achieve excellent distortion figures in both mono and stereo without requiring the user to switch to the narrow mode except in rare instances of severe interference. Figure 1 shows quieting and 1-kHz distortion characteristics with increasing signal input levels for the wide mode, while in Fig. 2 we see graphs of the same parameters for the narrow mode. Note that ultimate S/N for a 15-kHz audio bandwidth remains very nearly the same for both conditions, as does mono usable sensitivity (11.0 dBf) and 50-dB quieting (15 dBf in mono, 37 dBf in stereo). The differences in performance from one setting to the next are largely confined to differences in distortion and stereo separation. THD in mono, in the wide mode for a 1-kHz signal, measured a low, low 0.06 percent, increasing to 0.075 percent in stereo. In the narrow

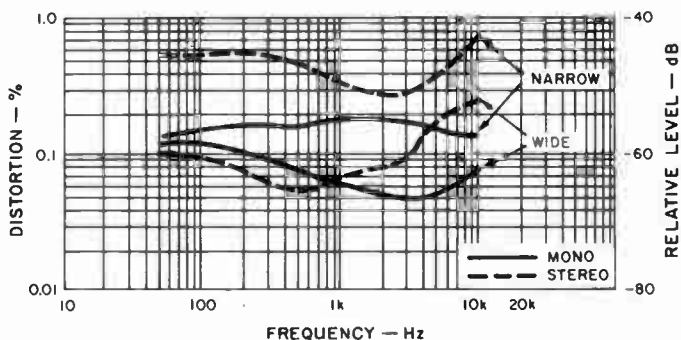


Fig. 4 — Distortion vs. frequency, FM tuner section of the Mitsubishi DA-R20 receiver.

three-stage equalizer amp with low-impedance negative-feedback circuitry. A three-stage d.c.-coupled tone-control amplifier with differential input stage comes next. The main amplifier is also d.c.-coupled, from input to output, and speaker selection is via two replays. D.c., low-impedance, and delayed turn-on protection circuits are incorporated in the receiver's power amp section.

FM Tuner Measurements

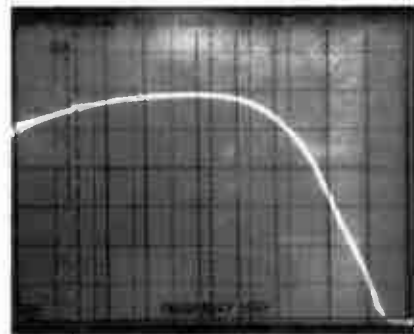
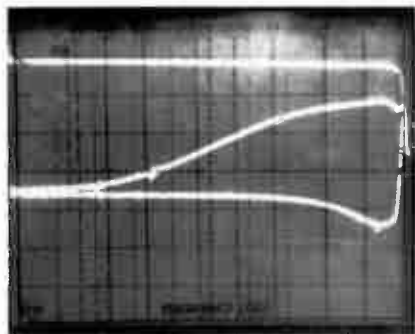
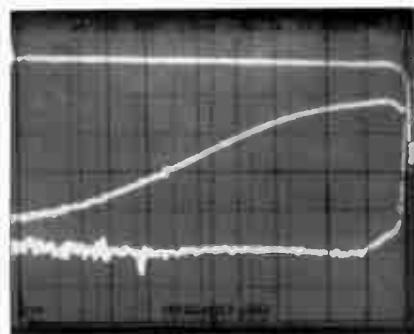
This tuner section is one of a very few which utilizes the idea of selectable bandwidth for greatest listening advantage. In the wide mode, we measured an alternate channel selectivity of 58 dB, or very close to the 60 dB claimed, while in the

mode, mono THD at 1 kHz read 0.18 percent, increasing to 0.34 percent in stereo. Figure 3A is a spectrum analyzer plot of frequency response and stereo FM separation using the wide i.f. mode. The sweep in this and other spectrum analyzer displays is from 20 Hz to 20 kHz, and vertical sensitivity of the display is 10 dB per division.

Separation at the three IHF-required test frequencies of 1 kHz, 100 Hz and 10 kHz was 58 dB, 54 dB and 48 dB. Note the almost straight-line crosstalk characteristic (lower traces of Figs. 3A and 3B; this is remarkable for any stereo FM decoder circuitry. The middle trace of each figure shows how separation is compromised when the blend switch is turned on to reduce background noise of weak-signal FM stations. In the

Fig. 3 — FM frequency response and stereo separation for wide (A) and narrow (B) bandwidth settings. Middle trace is separation with blend filter on.

Fig. 5 — AM frequency response.



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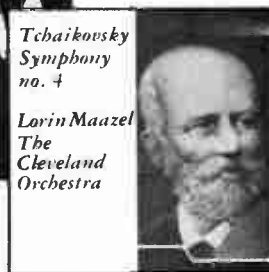
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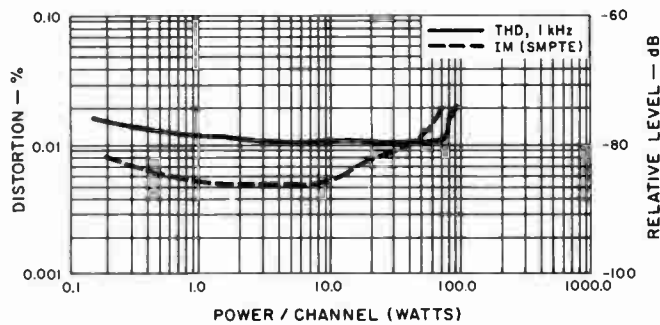


Fig. 6 — THD at 1 kHz and SMPTE-IMD vs. power output per channel.

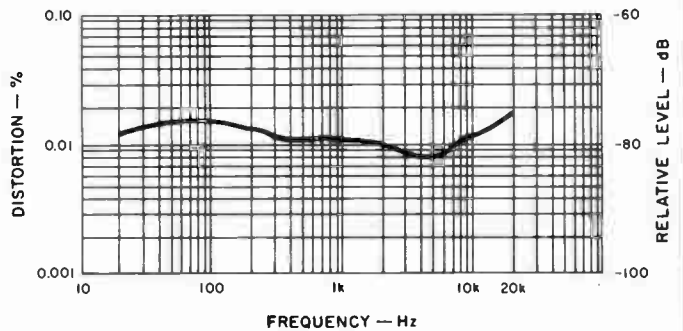


Fig. 7 — THD vs. frequency at rated output.

narrow i.f. setting, separation decreased to 44 dB at 1 kHz, 42 dB at 100 Hz, and 39 dB at 10 kHz—all still very acceptable separation figures for any tuner.

Capture ratio measured 1.3 dB, while AM suppression, image, i.f. and spurious rejection were all just about equal to published claims. Frequency response was within 0.5 dB of flat from 30 Hz to 15 kHz. Distortion versus frequency for mono and stereo and for both the wide and narrow i.f. settings is plotted in Fig. 4.

AM tuner section frequency response was typical of that found in most stereo receivers and was 6 dB below a 1-kHz response reference at 2.5 kHz, as shown in the spectrum analyzer plot of Fig. 5.

Amplifier Measurements

With a 1-kHz input test signal, the amplifier section of the DA-R20 receiver was able to deliver 87 watts of continuous power per channel into 8-ohm loads as against its 60 watt per channel rating. This output level resulted in a rated THD level of 0.02 percent, as graphed in Fig. 6. An SMPTE-IM distortion level of 0.02 percent was reached for an equivalent power output level of 76 watts per channel, both channels driving 8-ohm resistive loads. At the frequency extremes of 20 Hz and 20 kHz, the amplifier delivered 85 and 82 watts per channel respectively for the rated THD level of 0.02 percent. Power bandwidth extended all the way up to 35 kHz (for 60 watts output at 0.02 percent THD), and the amplifier could be legitimately rated at something greater than 80 watts per channel as against the conservative 60-watt rating assigned by its manufacturer. Damping factor at 50 Hz measured just over 100. Slew factor measured 50 volts per microsecond, as claimed.

We were somewhat surprised to find that the IHF dynamic headroom was far better than claimed. We measured an unusually high figure of 2.6 dB for this relatively new specifica-

tion, and it may be that the people at Mitsubishi are misinterpreting the measurement procedure for dynamic headroom, thereby doing themselves an injustice in quoting only 1.0 dB for it. Figure 7 is a graphic plot of harmonic distortion versus frequency for a 60 watt per channel output level driving 8-ohm loads.

Phono input sensitivity for the MC input mode was 0.018 mV (for 1-watt output) and 0.32 mV for the MM inputs. Phono overload occurred at 150-mV input (1 kHz) using the MM inputs and at 14 mV for the MC inputs. Signal-to-noise ratio for MM phono measured 85 dB (new IHF method), while for the MC inputs it was 77 dB. High-level input sensitivity for 1-watt output was 19 mV; S/N ratio, again referred to 1-watt output (for 0.5-volt input) was 88 dB, increasing to 91 dB (still referenced to 1 watt) with the volume control at minimum setting.

RIAA equalization was accurate (via either the MC or MM phono inputs) from 20 Hz to 20 kHz to within ± 0.2 dB. Frequency response via the high-level inputs was flat from d.c. to 95 kHz for a -2.0 dB roll-off.

Bass and treble control range of the tone controls supplied on the DA-R20 is plotted in the 'scope photo of Fig. 8, while the action of the separate loudness control is shown in Fig. 9. Note that the total range of this control (at mid-frequencies) is approximately 23 dB. In use, the listener would set the master volume control for lifelike loudness levels and the secondary loudness control to its flat (clockwise) position. Then, if lower-than-live listening levels are required, the user simply turns the loudness control counterclockwise (leaving the master control at its original setting) for proper and meaningful loudness compensation. Judging from the results obtained in the plot shown in Fig. 9, Mitsubishi seems to have gone a bit overboard in treble compensation (some even maintain that no treble compensation is actually required). In every other way, however, the design of this sepa-

Fig. 8 — Tone control range, Mitsubishi DA-R20.

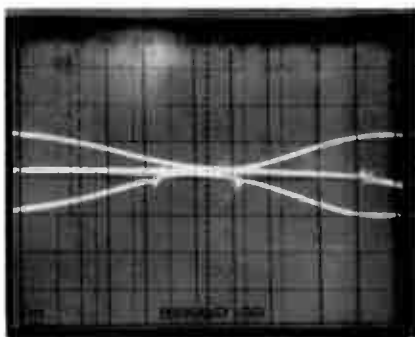
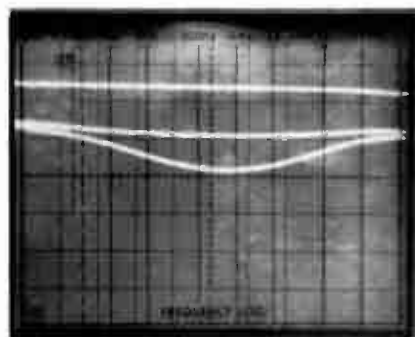
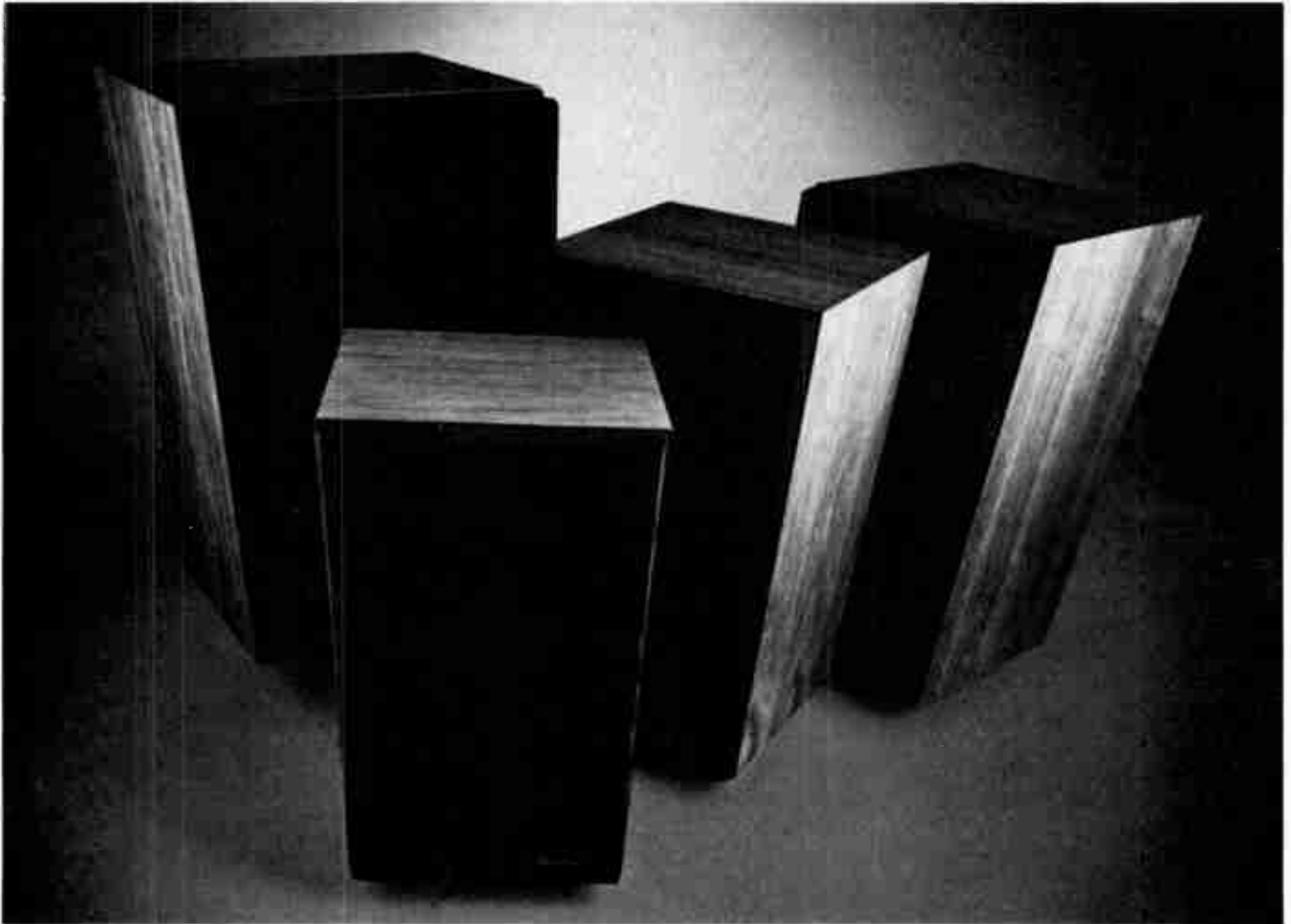


Fig. 9 — Loudness control range.



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rate loudness control system is just as it should be, and it is far more effective than those arbitrary types which simply convert the volume control into a loudness control without paying any attention to actual program source or ultimate listening levels.

Use and Listening Tests

We spent several days using the Mitsubishi DA-R20 as the central component in our reference listening setup in the lab and in our separate listening room, using both FM and records as program sources. We enjoyed using the set for FM reception, the more so because we found its i.f. and detector system to be in perfect alignment relative to the meter and frequency indications. The AFC lock feature was close enough to providing optimum lowest-distortion tuning so as to discourage any quibbling about this feature on our part. And, although bench measurements showed that usable sensitivity was a bit higher than claimed, we had no trouble receiving distant stations with good quieting once we connected our reference outdoor antenna to this unit. Some of the received signals, known to be of approximately 20 to 50 μ V signal strength in our listening location, came through with virtually no audible background noise in mono and with tolerably little in stereo. As mentioned earlier, the muting threshold (at around 10 μ V, or 25.2 dBf) presented no problems or the need to switch from stereo to mono. AM reception, though limited in response, did seem to have a bit better quieting characteristics and somewhat lower distortion than some of the competition, though this should not be taken as an unqualified compliment for this or virtually any other AM tuner section found in modern stereo receivers.

Amplifier performance was essentially on a par with that of

the FM tuner section. The first thing that struck me about the preamp/amplifier combination when I started playing wide dynamic range records was that it seemed to be able to provide far higher output levels than its rated power figures would suggest. That is where the high dynamic headroom comes into its own. At a measured 2.6 dB, we calculated that short-term power peaks (such as are now increasingly present in digitally mastered discs and some direct-to-disc recordings) could successfully drive this amplifier to peak output power levels of over 100 watts per channel! In recent testing, I have taken to using some dbx-encoded discs as program sources, especially when judging the dynamic range handling capability of a given piece of equipment. The DA-R20 did surprisingly well when such discs, properly decoded, were used as a source.

One of the people at Mitsubishi Electric Corp. (or, more factually, at Melco Sales Inc., the U.S.-based subsidiary of Mitsubishi) suggested to me that, as an established manufacturer of separate components, the company utilized to as large an extent as possible the circuit designs and functions already present in their separates. He went on to suggest that to build a product in a lower price range (relatively speaking), some compromises were necessary, but that the company attempted to reduce overall price by the omission of non-critical features rather than any changes in circuit configuration or quality of parts. Judging by my tests on the bench and in the listening room, I would say that these objectives were very successfully achieved. The Mitsubishi DA-R20 is not an inexpensive receiver in its category, but it is one which, in many ways, performs as well as separate components whose total price could easily exceed the cost of this model.

Leonard Feldman

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World Radio History

Shure SM-81 Unidirectional Condenser Microphone



Manufacturer's Specifications

Type: Cardioid condenser (electret bias).

Frequency Response: 20 to 20,000 Hz.

Polar Pattern: Cardioid.

Output Impedance: Rated, 150 ohms; actual, 85 ohms.

Recommended Load Impedance: 800 ohms minimum.

Output Level at 1 kHz: Open circuit voltage, -64 dB (0.63 mV), 0 dB = 1 V/microbar; power level, -39.5 dB, 0 dB = 1 mW/10 microbars.

Maximum Input Level: With 800-ohm load at 1 kHz, 135 dB with attenuator at 0, 145 dB with attenuator at 10.

Hum Pickup: Typical, -4 dB equiv. SPL in a 1 millioersted field; -144 dB re: 1 mW in a 0.001-Gauss, 60-Hz magnetic field with 150-ohm load.

Noise Level: 16 dB typical, "A" weighted; 19 dB typical, DIN 45 405 weighted.

Phasing: Pin 2 is plus.

Low-Frequency Response Compensation: Three position switch; flat, -6 dB/octave below 100 Hz (roll-off), or -18 dB/octave below 80 Hz (cut-off).

External Power Required: Simplex (phantom) system, 12 to 48 V d.c. at 1.25 to 1.75 mA.

Environmental: -29 to +57 degrees C, 0 to 95 percent R.H., integral r.f. filter.

Case: Steel with metallic vinyl finish.

Dimensions: Overall, 15/16 in. (23.5 mm) dia. by 8-11/32 in. (212 mm) L.

Weight: 8 oz. (230 g).

Cable: 25.3 ft. (7.6 m).

Accessories Furnished: Pop screen, 49A41; swivel adaptor, A57D; 10-dB attenuator lock, 34A830.

Accessories Available: Power supply PS-1, \$113.40; external pad A15AS, \$27.60; 14-ft. tripod stand S15, \$89.40; windscreen A81WS, \$18.75; stereo mike adaptor A27M, \$22.05.

Price: \$250.00.

The Shure SM-81 is a high-quality electret system designed for studio recording, broadcasting, and sound reinforcement applications. In addition, the microphone and accessories comprise a complete system that is suitable for on-location music recording by audiophiles. The microphone may be permanently installed in inaccessible locations since d.c. power is supplied remotely. The phantom (or, as Shure terms it, Simplex) powering scheme allows ordinary two-wire shielded microphone cable to be used between the microphone and the unit providing power. (This scheme has been

discussed in previous reviews of air condenser [non-electret] microphones.)

The condenser capsule unscrews from the preamp and may be quickly replaced. This feature is common to the several condenser microphones we have reviewed in *Audio*, but the SM-81 is the only one (at this writing) that lacks alternative capsules.

An integral 10-dB attenuator is provided between head and preamp and is selected by a rotating ring behind the capsule. This switch may be locked by the accessory provid-

ed. The attenuator reduces the output of the capsule, preventing clipping of the preamp on very loud sounds (above 135 dB SPL). If, on the other hand, the user's input amplifier is being overloaded, the problem may be solved by using the 10-dB pad at the expense of a 10-dB loss in S/N or, more properly, by using an external pad, such as Shure's newly introduced A15AS.

Many recording locations have low-frequency rumble that is picked up by condenser microphones having uniform frequency response to 20 Hz and below. (As a matter of fact, we have not yet found a site that will permit us to use the low-frequency boost equalizer designed for another condenser microphone — see *Audio*, September 1978.) The low-frequency response of the SM-81 may be varied by the integral three-position switch. This built-in filter is an advantage to the audiophile who does not have suitable filters or equalizers in the mixer or recorder. A low-frequency response equalizer may also be used to compensate for "proximity effect," which is the bass boost exhibited by pressure-gradient microphones when the sound source is closer than three feet. Figure 8 of the instructions shows that the middle switch position does provide compensation for a source distance of six inches.

The preamp includes an r.f. filter at the connector which is good for broadcast stations and recording sites with high r.f. interference.

The machined-steel housing appears to be as durable as an iron pipe, and may contribute to the very low sensitivity stated for magnetic hum pickup. The specifications omit a reference to frequency and Shure confirms it is for 60 Hz; hum sensitivity normally increases with frequency. The case finish is a vinyl paint which looks exactly like nickel plating over an abrasive blasted surface, and seems to have similar resistance to scuffs.

Laboratory Measurements

We would like to remind the reader that all measurements were conducted in accordance with our articles on microphone testing in the April 1977 and September 1978 issues of *Audio*.

All tests on the SM-81 were made using a PS-1 power supply. The impedance test produced the curious results shown here in Fig. 1. The "unbalanced" measurement yielded 100 ohms at 1 kHz, which is close enough to the 85 ohms specified for actual impedance. The "balanced" test was conducted similarly except a 200-ohm isolation transformer was inserted with primary windings ungrounded. The instructions do not state what input circuit configurations may be used, although the minimum load Z (800 ohms) is specified. We questioned the factory engineers who indicated the SM-81 may be used with balanced or unbalanced leads. Normally we use a broadcast-type amplifier with a grounded center tap on the input transformer. Careful acoustic tests revealed that the SM-81 frequency response and sensitivity had no measurable variation when our input transformer strapping was varied between unbalanced, balanced-floating, and balanced-CT grounded. (*Editor's Note:* Shure tells us that the impedance vs. frequency data, presented in Fig. 1, do not agree with their laboratory measurements for the balanced condition. In addition, they do not achieve different results at low frequencies for an unbalanced condition depending on grounding pin 2 or 3. Their data indicate that as long as the microphone electronics are not overloaded, the output impedance will go up very slightly, approximately seven ohms, as measured in a balanced as compared to an unbalanced state when measured through a PS-1 power supply. This difference is a result of creating an a.c. short [unbalanced condition] across one of the two biasing resistors in

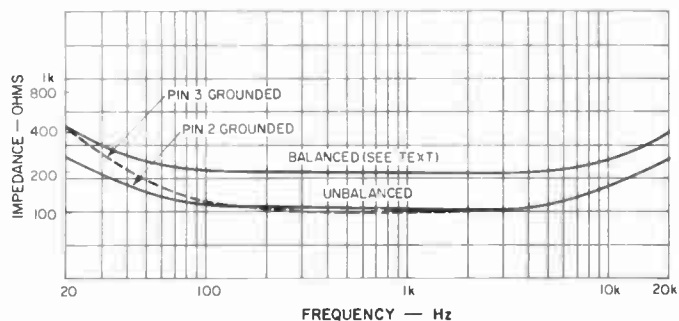


Fig. 1—Impedance vs. frequency.

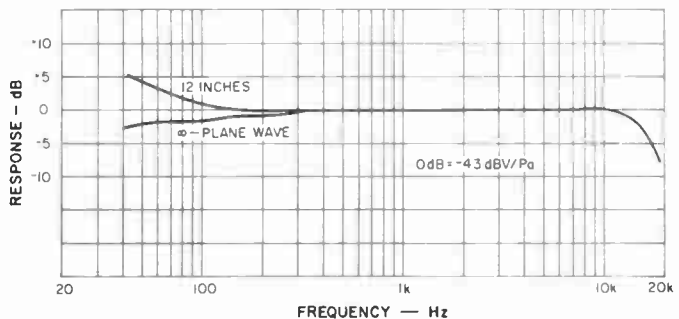


Fig. 2—Frequency response.

the PS-1. However, the actual output impedance of the microphone is not changed. In reviewing the statement regarding the balanced measurement, Shure is concerned about the influence of the 200-ohm isolation transformer, since a transformer is not required for such measurements.)

The frequency-response curve (Fig. 2) indicates that for most practical source distances, the low-frequency response will be flat to very low frequencies, or substantially bass-boosted. Figure 3 illustrates the measured response compensation. The center switch position provides linear response at 12 in. as predicted earlier. At 50 Hz we measured 7.5-dB attenuation with the *Rolloff* setting and 12.5 dB with the *Cutoff* setting. This agrees with Fig. 1 of the data sheet, but disagrees with the attenuation values of Fig. 8, which we think is in error. (*Editor's Note:* Shure tells that later printings of the data sheet will agree with the differences shown in Fig. 1 of the sheet.) We tested two microphones for axial frequency response, and Fig. 4 shows the performance of the units. The

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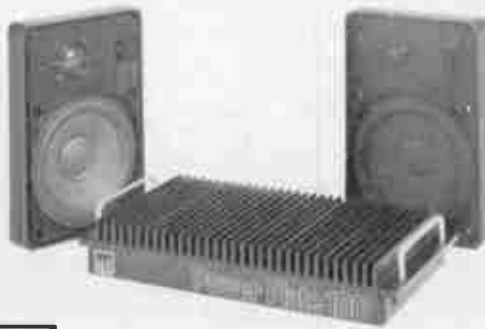
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low-frequency differences were insignificant. There were no variations in high-frequency response, except for the roll-off above 15 kHz, which is quite remarkable. The data sheet shows this roll-off with somewhat higher response levels, from 15 kHz to 20 kHz. (Editor's Note: Shure's published frequency response curves are based upon free-field measurement using a Bruel and Kjaer Model 4133 flat free-field condenser microphone and disagree with the review measurements at 20 kHz by approximately 3 dB, Shure's data showing a higher level.) This phenomenon is easy to understand, because a pressure microphone of 24-mm diameter (example: W.E. Co. 640AA) exhibits a similar high-frequency response variation.

Figure 5 shows that the 90-degree response rolls off above 10 kHz and the 180-degree response tends toward omnidirectional properties at high frequencies. Both phenomena are presumably related to the microphone diameter. (Refer to *Audio*, September, 1978, pg. 91 for an example of improved linearity in high-frequency characteristics with a 16-mm diameter capsule.) The 180-degree response has a good (20 dB) null at 1 kHz, but measures 10 dB or less at 100 to 200 Hz. The polar pattern in the data sheet shows that the cancellation is reduced to 15 dB at 100 Hz. The difference may be attributed to imperfections in our indoor test setup where we usually cannot achieve more than about 15 dB front-to-back ratio below 500 Hz even with a microphone. We might have been able to measure better than 10 dB with our more accurate outdoor setup (*Audio*, September, 1978). (Editor's Note: Shure comments that the low-frequency response is greatly influenced by the nature of the sound field presented to the microphone. If, for example, the sound field were truly free field, equivalent to being a very large distance from a point source, the 180-degree response measured at 1 kHz would continue to hold down to an extremely low frequency.)

Figure 6 shows the major advantage of a 24-mm diameter microphone: Low equivalent-input-noise level. This results from large diaphragm area (and correspondingly high electrostatic sensitivity) plus a very low-noise discrete semiconductor preamplifier. The 16 dB "A" weighted equivalent SPL noise level is lower than any value we've previously measured for a microphone of this size. Our results agree exactly with the revised data supplied by Shure. (Originally, higher values had been specified.) The noise of the SM-81 is so low that the user should take care in selecting a suitably low-noise mixer so that S/N is controlled by the microphone and not by the mixer.

The phase test showed pin #2 is positive, as specified, and clipping levels were essentially the same as specified. The hum sensitivity was about 15 dB less than our reference microphone, and we estimate that the SM-81 meets specifications. The SM-81 is very insensitive to magnetic hum and can probably be used in many places where other microphones would have objectionable hum.

Listening and Use Tests

In past reviews we have employed a broadcast-quality cardioid ribbon microphone as a reference for listening comparisons. In our review of the Nakamichi CM-700 (16-mm diameter) electret condenser microphone (*Audio*, September 1978), we noted that our reference ribbon microphone was substantially inferior at very high frequencies. The CM-700 system includes both cardioid and omni capsules. Since the response of the omni capsule met ANSI specifications for 13 mm (½ in.) laboratory microphones, we concluded that this system would be excellent as a listening reference for future reviews of omnidirectional as well as cardioid microphones. (We are not implying that the CM-700 system is superior to all other microphones. It has very uniform response and

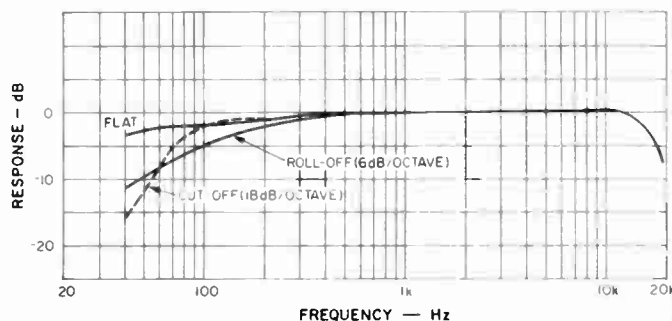


Fig. 3—Frequency response vs. low-frequency switch position.

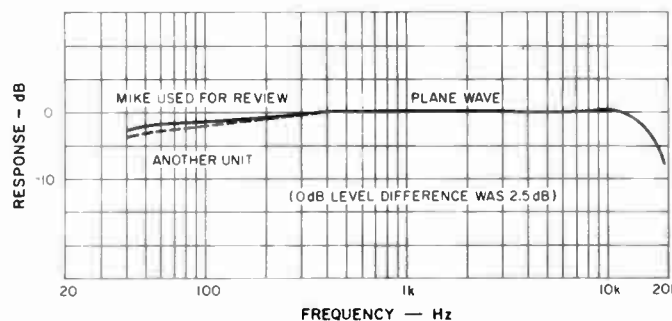


Fig. 4—Frequency response variation between two production microphones.

directivity with respect to frequency, but has many practical disadvantages such as lack of remote powering, higher noise level, and delicate-looking condenser heads.) We used the CM-701 cardioid head for comparison to the SM-81.

Without a windscreen or popscreen, the SM-81 is very sensitive to wind and "pop," and will "thump" when moved about in still air. "Pop" sensitivity is higher than the reference cardioid microphone when each is covered with its small popscreen. The SM-81 had "pop" sensitivity equal to the reference microphone when the *Lo Cut* switch was set for maximum attenuation (reference microphone on "flat" response). The large Shure windscreen eliminated "pop," but not "thump." The higher wind sensitivity of the SM-81 is a logical result of its extended low-frequency response, but we are a little concerned about the "thump," which might happen outdoors or in a drafty room. Subjectively, the "thump" sounded like blocking of the first stage in the microphone electronics. We questioned the manufacturer who indicated they experienced similar effects and traced it to overloading of the mixer or tape recorder input stage. They stated that if "thump" is heard, it can be eliminated by reducing the microphone output level with the integral attenuator or a separate pad ahead of the mixer.

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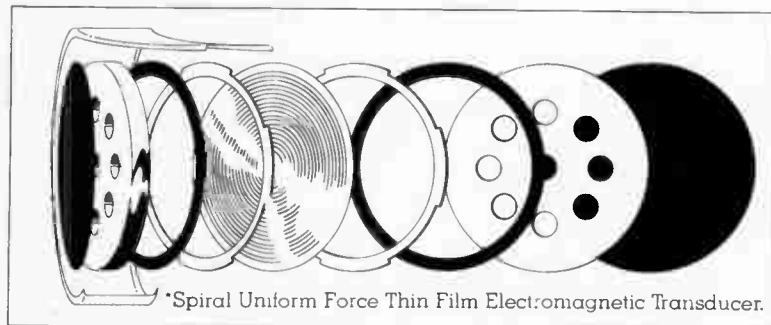
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Vibration and handling noise proved to be significantly lower than the reference microphone.

Laboratory listening tests were conducted with voice and acoustic guitar. On axis the SM-81 sounds the same as the reference mike with voice, but at 90 degrees off axis it sounds more muffled. With guitar, we heard somewhat less high-frequency overtones on axis and much less overtones at 90 degrees off axis. Proximity-effect compensation is effective at 12 in. as shown by tests, and the voice sounds "boomy" at six in. or closer. (Editor's Note: Shure comments that the SM-81 has flat and extended on-axis high-frequency response, and that this response shape is also maintained at other angles of sound incidence including random incidence. In an A-B test with another microphone, listening comments indicate that the other microphone has a peaked-up high-frequency response, and that this peak is further emphasized as the comparison microphone is moved 90 degrees off axis.)

We had the opportunity to record a string quartet plus piano with a pair of SM-81s mounted on the S15 stands, and used with PS-1 power supply plus Shure A95UF transformers into a ReVox A77 recorder. The musicians would not permit a single S15 stand in front of the group, so we couldn't try out the A27M stereo microphone adaptor (which we found to be a cleverly designed accessory). The SM-81s were 14 ft. above the musicians in the chancel area of a large, reverberant ($RT_{60}=3$ S) church. The acoustic environment was totally inappropriate for chamber music, but the SM-81s reduced the perceived RT to very acceptable values. We were privileged to have the tape auditioned by a distinguished patron of the arts who is also an accomplished cellist. Until we informed him to the contrary, he assumed the recording was made in a smaller room with relatively dead acoustics. He praised the audio quality which he indicated was limited only by the fact that the instruments were not top-quality, such as Stradivarius and the like. In this instance, the microphones were far enough above the musicians that no instrument was more than about 20 degrees off axis. Lacking an A-B test with the reference microphone, any lack of top-octave overtones were not noticed, even by the expert. For this recording, we used the capsule attenuator "improperly" to reduce microphone sensitivity so that knob settings on the ReVox would be "normal." The degradation in S/N was not noticed above ambient room noise or tape noise.

The S15 stands are quite remarkable pieces of hardware. Although they extend to 14 ft., they collapse to about 3 ft. and fit into a soft carrying case that can be carried aboard an airliner. We have used one for environmental noise testing in locations ranging from Puerto Rico to Chicago. We have only one minor complaint—the tube section rattles and was first heard outdoors in Puerto Rico where the wind velocity was 10 to 15 knots all day. We later tried the S15s with the reference microphones to record a concert and thought that the sound quality was significantly improved over previous recordings with these mikes. This was a dramatic demonstration that positioning can be relatively more important to good audio than the choice of microphone (when each is a high-grade professional unit).

Conclusions

We are very pleased with the biomechanics and potential durability of the SM-81. The case is not easily marred, and the flat surface protects the *Lo Cut* switch and also prevents rolling. The switches are easy to operate without tools, and the front screen is very rigid and not easily dented.

We would like to see an omnidirectional capsule available for this system, since it would be useful in many instances for preserving natural ambience of auditoriums, as well as for vocal and hand-held applications. An omnidirectional micro-

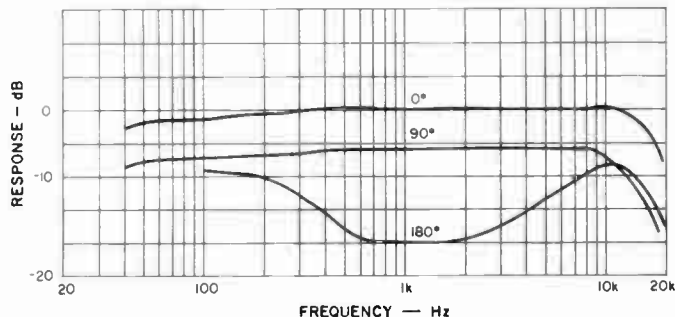


Fig. 5—Frequency response vs. angle.

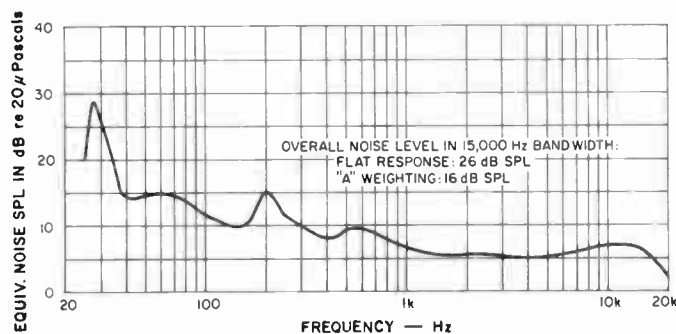


Fig. 6—One-third octave band spectrum of noise from SM-81 microphone with "0 dB" and "Flat" response settings.

phone simplifies close miking of instruments, although some will argue that it reduces the acoustic isolation between instruments.

We can recommend the SM-81 for all pop music applications because it is particularly suited for high SPL in close miking and has integral low-cut filters. It can be used for very close vocal pickup in combination with an external proximity-effect equalizer, as well as for hand-held vocals. If "thump" is a problem in this latter use, the integral attenuator or external pad will eliminate it. In classical music pickup, it is well suited to permanent installations where the microphone is "flown" high above the orchestra and where high-pitched instruments, such as strings or harpsichord, are not far off axis. The SM-81 is also especially suited to sound pickup of low SPL instruments, such as the virginal and clavichord, because of its low noise level. Undoubtedly, it will be a problem solver for high electromagnetic and r.f. interference locations.

Jon R. Sank

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The bookshelf

The Preservation and Restoration of Sound Recordings by Jerry McWilliams. The American Association for State and Local History, 1979, 138 pp., \$8.95, \$7.00 to AASLH members. (AASLH, 1400 Eighth Ave. South, Nashville, Tenn. 37203.)

Archivists and librarians confronted for the first time with the task of setting up and maintaining an archive of recorded sound are usually perplexed as to how to go about it. Fortunately, there is now no need to despair as the author of this work has compiled in one small volume the rudiments on the subject as well as techniques for the preservation and restoration of sound recordings.

The first chapter presents a brief history of the development of recorded sound and the evolution of cylinders, discs, and tape recorders, concluding with the modern digital sound recording. In the second chapter, the author covers the preservation of sound recordings with recommendations for the storage of cylinders, discs, and tapes as well as the playback of these recordings and of wire recordings. Excellent sections on disc washing and cleaning and the maintenance and storage of records and tapes are included. The most important elements for the playback of records — cartridges, styli, tonearms, and turntables are adequately discussed. A product recommendation section is included for those in need of related audio equipment.

The chapter on the restoration of sound recordings is good but, we feel, too brief. A few do-it-yourself items could have been included such as a simple notch filter for eliminating 60-Hz hum, a presence control which is useful in playback of acoustic recordings, and information on the wiring of a stereo cartridge for the playback of mono records without the vertical noise present on these records. The final chapter offers recommendations to archives and libraries on storage, environmental controls, access, equipment, services, and copyright policies. The balance of the book includes a Directory of Manufacturers and Suppliers, Directory of North American

Sound Archives, Bibliography, and Index. Unfortunately, errors in the spelling of company names and their addresses have crept into the directory. The index is passable.

Although the book contains some errors and omissions, we find it to be a very worthwhile contribution for the beginning archivist or librarian, but too elementary for established archives and libraries of sound recordings. However, it includes a lot of useful information that should prove most helpful to the audiophile whose collection sometimes rivals that of some libraries.

B. V. Pisha

The Concerts by Laurie Lewis. Paper Tiger/A&W Visual Library, 120 pp., \$12.50, paperback.

My friend Neil Benson, who shoots pictures and covers events for big magazines and wire services, tells me that concert photography is one of the easiest things he does. For several reasons. First, there is no question where you must look to find your subject — right in front of you on the stage. Second, the lighting is being done for you. The only really difficult part, says Neil, is getting access to be close to the stage. It is with these ideas in mind that I approach this lavish book of Laurie Lewis' rock concert photography which covers most of the '70s.

Technically, it is a beautiful book with exquisite, rich color and superb reproduction throughout and printed on fine heavy-stock paper. Unfortunately, Lewis' work simply does not offer any insight into the people on stage. It merely captures them there as caricatures in most typical moments of stage action. All you really learn is that Mr. Lewis went to a lot of concerts last decade. Even in the index, which is otherwise quite complete, there is a serious omission: The photos are not dated, something that in one easy stroke would have given the book at least the perspective of time.

Neil further suggested that a far more interesting book would be a collection of the work of *Rolling Stone's* Annie Leibovitz who really communicates about her subjects in her work. He's right, too.

Michael Tearson

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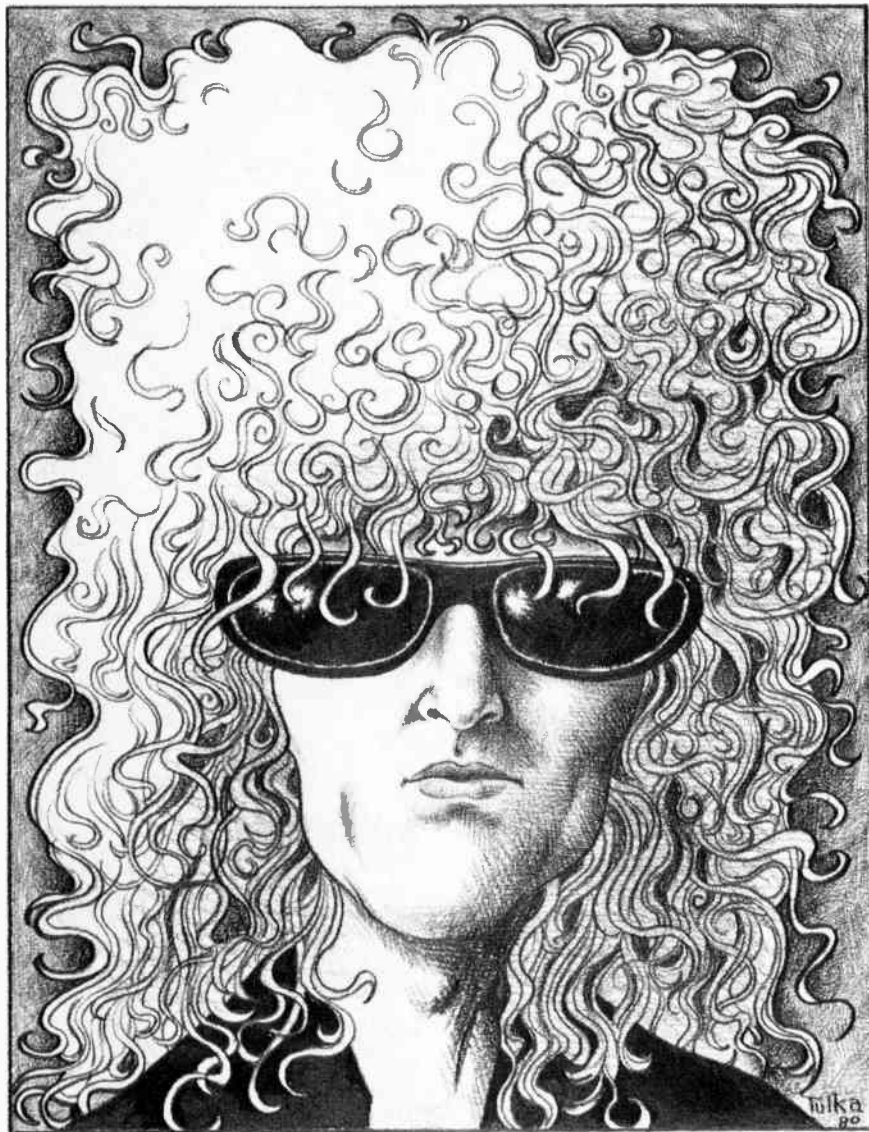
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The column



Welcome to the Club: Ian Hunter
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One must view Hunter's latest recording effort with a certain amount of initial disdain — two albums in five years and one merely a "Greatest Hits Live" — but the performances on **Welcome to the Club** end up totally justifying the package, sort of as a companion to Columbia Records' recent career-sweeping **Shades of Ian Hunter**.

If for no other reason than the side of new material, Hunter and Mick Ronson have come across with a delightful piece of listening material.

I suppose if you spend as much time on the road as they did last year you want something to document it, and this album does an accurate job, although it would have been nice to feature drummer Hilly Michaels on at least one or two cuts. (Michaels played on the first half of the tour but had to leave to begin work on his solo album after a few months.) The Hunter/Ronson show came off somewhat overblown, as there were between 8 and 10 people onstage at any one given time; with that many things going on the sound man is apt to get confused but with the ability to remix in the studio.

the material comes across as being far more cohesive — even with three guitars, two keyboards, and a cast of screaming audience members. My major gripes with the album are (1) a third of the live tracks are also found on **Shades of**, (2) it seems a little too soon after **You're Never Alone with a Schizophrenic** to redo so many of that album's tunes, and (3) there were some terrific numbers I saw them do live that they failed to include.

The new stuff, on the other hand, gives us nothing to complain about. *Man O' War* is an all-stops-out rock 'n' roll killer, complete with nasty lyrics and obscene backup vocals; *We Gotta Get Out of Here* isn't one of Hunter's greatest compositions but has a lot of things going for it that are currently in vogue which could make it a hit, as well as amusing commentary by Susie Ronson and Ellen Foley; *Silver Needles* is a song about dying rock stars, and then there's a heartfelt apology to wife Trudy for not wanting a family called *Sons & Daughters*.

Whether Hunter is at his best without overdub facilities is debatable, but as this is probably the first live recording of the gent which was mixed properly it certainly belongs in every Hunter fan's collection. The man is one of the major artists of rock, and one would hope that he's got more new material than this on tap so he can deliver the *real* goods in the not too far distant future. *Sally and Jon Tiven*

Sound: B+

Performance: B+

McCartney II: Paul McCartney
Columbia FC 36511, stereo, \$8.98.

Turn me on, dead man! Although the title is misleading (**Ram** was actually the second solo LP), this is the first Paul McC album that even John & Yoko are certain to enjoy. Self-indulgent to the nth degree, McCartney manages to bring a warmth and genuine lunacy to disc which sounds primarily as if this album was created simply for the sake of fun. Macca plays all the instruments and only wife Linda is allowed into the kitchen to sing along. The sound quality is obviously somewhat limited as it was recorded at home without the aid of a console (kudos to whoever mixed it).



The songs are somewhat disjointed and often devoid of commercial intent, yet McCartney's native melodic gift and ingrained sense of what is likable make **McCartney II** a highly listenable work practically all of the way through.

My sources inform me that originally this was to be a two-record set, and I would guess that the main thrust of what was left off was instrumental. (There are two songs lacking lyrics

here, both of which are immensely enjoyable, and synthesizer noodling plays a major role on the rest of the tracks as well.) For my money the best tune on the record is a fun rock/R&B pile-driver called *Nobody Knows* which shuffles along joyously, despite some rather rough drumming from Mr. McC. The single *Coming Up* is quite amusing (although more so with the video accompaniment). Paul does his best imitation of Emmitt Rhoades-meets-B.B. King called *On the Way*, tries his hand at New Wave with a cute rewrite of *Paperback Writer* re-named *Temporary Secretary*, and even delves into the roots of his beginnings with a slight tongue in cheek number entitled *Bogey Music*.

The main difference between this and a Wings album is a less-slick presentation and a tendency not to try to be predictable, hinted at in previous works such as *Backwards Traveller* and *Goodnight Tonight*. I can't see him going on in this direction for any length of time, but as a break between Wings albums, it's certainly an interesting set of diversions and shows his continual growth as a songwriter in a slightly different perspective.

Jon & Sally Tiven

Sound: B-

Performance: A

A Little Warmth: Steve Gillette
Regency REG 79002, stereo, \$7.98.

On the release of Steve Gillette's recent direct-to-disc album, I asked in print where any of his new material was since nearly all of that album's songs were over 10 years old. Well, the new stuff's on a fine new album called

A Little Warmth, produced with taste by Graham Nash of all people. It is a gentle album of love songs about people in varying stages of life. Most of the songs were written either solo or co- by Gillette, who clearly has not lost any of his ability to turn a phrase right around the heart.

A Little Warmth is a good name for a Steve Gillette album. His singing is charged with warmth. He's got the kind of voice that makes me care about the songs and who they are about. The collection is a smooth one with the non-Gillette songs complementary to those he wrote. The arranging is exemplary, the backing vocals often ingeniously placed.

With **A Little Warmth**, I truly welcome back an old friend with whom I'd long since lost touch. It's only been something like 12 years since his still-classic Vanguard album, but it's a real good feeling to have a fresh clutch of Steve Gillette's songs in hand. M.T.

Sound: B

Performance: B+



Sue Saad & The Next
Planet P-4, stereo, \$7.98.

Dollars to donuts this group was wearing beards and workshirts until six months ago, playing cover tunes of Eagles tunes in L.A. bars. Their record sounds about as New Wave as Barry Manilow, and with half his sincerity.

With or without black leather, they still aren't New Wave, punk, tough or talented. Strike one against producer Richard Perry, whose taste this time is in the terlet. J.T.

Sound: B

Performance: F

The Records

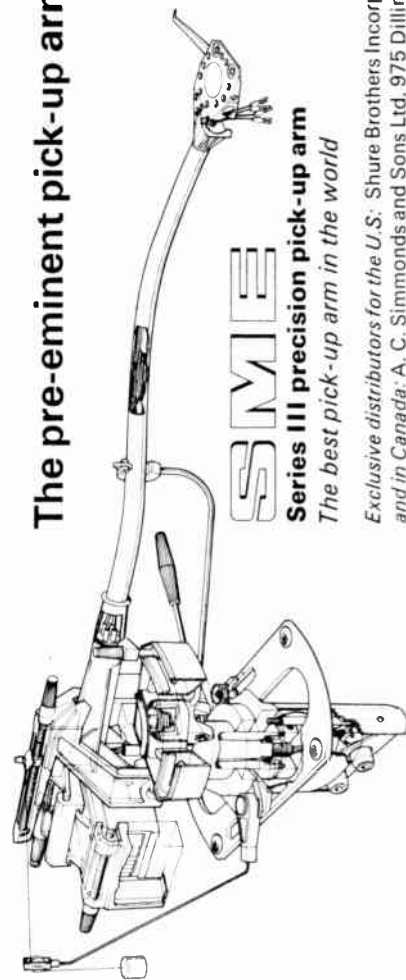
Virgin VA 13130, stereo, \$7.98.

There's a type of music going around today that's sort of halfway between pop-Beatles and New Wave that first seemed to gain prominence with Eddie & The Hot Rods' *Do Anything You Wanna Do* and has most recently hit high on the charts with Brahms' *Girl of My Dreams*. With roots firmly in Big Star and early '70s power-pop, The Records epitomize this style. If you didn't get the point right away, they include FREE with their first album a bonus EP with cover versions of songs by Blue Ash, The Kinks, The Stones, and Spirit (not particularly great, but sort of interesting points of reference). They fare far better with original compositions like *Starry Eyes* and *Teenerama*, but I wish they had a little more personality of their own. Whenever I hear them on the radio, I first think they're The Rods, then Brahms, and finally the DJ announces The Records are responsible. The Records are good, but there's no Alex Chilton or Ray Davies in the group to make the personality something unique. Otherwise, not a bad debut for a group of this type. J.T.

Sound: B

Performance: B

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Live at The Paradiso: Link Wray Visa 7010, stereo, \$7.98.

This old rocker hasn't sounded so energetic since his early hits — with Robert Gordon he was an antiquated hepcat recruited to give the act some credibility, and his comeback albums for Polydor were far too laid back. But this live album captures Mr. Wray in fine form. Link is no great technician of the guitar, he's the kind of fellow who would rather bend a whole chord up and back a few times than move his fingers around the neck, although backed by the rhythm section from Spider (Jimmy Lowell and Anton Fig) he comes across with the kind of power that his music needs. Standards like *Blue Suede Shoes*, *I Saw Her Standing There*, and *Shake Rattle & Roll* are decimated with great noisemaking ease, while Link's *Rumble* and *Rawhide* are performed with wreckless abandon (as they should be). *Sally and Jon Tiven*

Sound: B Performance: A-

Warm Thoughts: Smokey Robinson Tamla TB-367M1, stereo, \$7.98.

Let's Get Serious: Jermaine Jackson Motown M7928R1, stereo, \$7.98.

Although Stevie Wonder's latest album may be a bit off the beaten track for fans of his previous hits, he's con-

Against the Wind: Bob Seger & The Silver Bullet Band

Capitol S00-12041, stereo, \$8.98.

A good album from a survivor. *Against the Wind* breaks no new ground at all for Bob Seger, but so surely and solidly does it cover the same ground as both *Night Moves* and *Stranger in Town* that its lack of adventure is no shortcoming. Seger sounds as comfortable as he could want on *Against the Wind*.

Upbeat songs like the very clever *Horizontal Bop* featuring Mac Rebennack on piano, *Her Strut*, and *Long Twin Silver Line* do have that touch of *deja entendu* about them, but they also have a smoothness like very old Scotch, and they promise to wear well over time. So, too, with a narrative ballad like *You'll Accomp'ny Me* or *Against the Wind*. Then there's Betty Lou's *Gettin' Out Tonight*, which is nothing but pure rock and roll and has no significance whatsoever.

The album's sound is smooth and round, and everybody sings and plays well. Really, about *Against the Wind* there isn't much to say beyond "Good show, Mr. Seger." *M.T.*

Sound: B Performance: B

tributed some fine and more conventional tunes to the albums of these two artists. In fact, Stevie's songs are pretty much the only reason why you'd want to get hold of these albums, which in Smokey's case is far below par and in the case of Jermaine, one still wonders whether he'd have a solo career if his father-in-law didn't run the record label.

Smokey Robinson's career had seemed to die down tremendously until his excellent single *Cruisin'* of a few months back, which sold a few copies and indicated that he was on the road to renewed greatness. Unfortunately, his new album is fairly dull.

The only Jackson who didn't follow his brothers to Epic Records gets the privilege of being produced by Stevie Wonder on three tunes written by the master — but what this sounds like are Stevie's demos with Jermaine's vocals added afterward. The title track is admittedly a lot of fun and fortunately lasts eight minutes; the other two are obviously cast-offs, and the rest of the material (co-authored by Jermaine with other writers) isn't particularly memorable. He sings nicely, and looks rather like brother Michael, but it's going to take a lot more than this to make him a star. *J.T.*

Sound: B+ Performance: D+

Glass Houses: Billy Joel

Columbia FC-36384, stereo, \$8.98.

Glass Houses is a more basic and stripped-down album than Billy Joel has made at least since **Turnstiles**. Following the lush, full arrangement of something like *Scenes from an Italian Restaurant* or as high-stepping a moment as Freddie Hubbard's trumpet solo in *Zanzibar* on **52nd Street**, I get the feeling that Billy felt boxed in and needed to try some relative simplicity.

Actually, the songs of **Glass Houses** are a typical Billy Joel collection with the usual strengths and weaknesses. There is an obvious hit in *You May Be Right* and a lovely bilingual ballad *C'E-tait Toi (You Were the One)*. And there is *Sleeping with the Television On*, one of Billy's better songs about not scoring chicks. Then there is *It's Still Rock and Roll to Me* which tips the hat to what Billy calls "the new sound." This one really is well-intentioned but is too smug and so emerges self-serving and somewhat pretentious.

By now the Phil Ramone/Billy Joel team is a classic case of hand-in-glove for record-making. **Glass Houses** has that traditionally rich, round Ramone sound, and Phil is smart and versatile enough to know when to use flourishes like accordion and synthesizers



without wearing out their welcome. More a retrenching than a new direction, a strategic retreat rather than a departure, **Glass Houses** is a good if transitional Billy Joel album calculated to keep the legions happy. That's all.
M.T.

Sound: B+ Performance: B



Hi: Elizabeth Barraclough
Bearsville BRK 6992, stereo, \$7.98.

Elizabeth Barraclough is a rough diamond as tough as nails. She has proved difficult to record effectively with her full-tilt, open-throated, and often undisciplined singing style. For her second album she has been paired with producer Willie Mitchell who cut so many classic tunes for Al Green, Ann Peebles and Willie's own Memphis Horns, among others, Mitchell's Hi Studios was the scene, and the

cast included much the same personnel as on the Green and Peebles records. In this gritty setting Ms. Barraclough seems reasonably at home, like a screaming Al Green.

Barraclough's own songs are appropriately tapped from a soul vein with enough timelessness to let *Devil at the Door*, *Gotta Lotta Love*, *Use Your Heart*, and a shuffling *So Good to See You* sound at one with a genuine oldie like *You'll Lose a Good Thing*. Side one plays like a loose soul revue.

On side two *Space Shuttle Shuffle* crosses the soul with *Telstar* for an instrumental kick-off. *Time and Love* (not the Laura Nyro song) is a torcher. The acoustic *Bird in a Cage* closes the album, a duet with Paul Butterfield blowing some heartbreaking harp as a riveting mate to the desolation of the lyrics.

Technically **Hi** is nothing special. Muscially, it is somehow out of joint with the fashion of the times, a throw-back to when soul music had to have heart too. Elizabeth Barraclough's songs and singing are somehow very satisfying despite some obvious flaws which paradoxically only make them that much more attractive. M.T.

Sound: C- Performance: B

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A three-note ostinato bass line accelerates the piece into an open-ended aerial travelog. Sadao Watanabe, the pre-eminent reed player of Japan, takes a soaring flute solo, propelled by the bass and highlighted by the jangling percussion. Shigeo Suzuki's twisted soprano brings the piece to a crescendo as Togashi switches to traps and the percussion becomes more earnest. Cellist Keiki Medorskawa picks up the soprano line and careens across an intensifying percussion wash with sinewy agility.

Masahiko Togashi has used percussion as the instrumental basis for **Spiritual Nature**. But instead of using them as an exercise in rhythmic dexterity or a percussion orgy, he has exploited them for their timbral shadings and colors. They form an organic unity with the strings and reeds that often makes them indistinguishable from each other.

Spiritual Unity is an engrossing listening experience that is born from a deep understanding and empathy on the part of Togashi and his ensemble.

It would have had a more heightened impact had the recording been miked and mastered with more care. There is just the slightest amount of hiss and a vague impression that some of the instruments were not supposed to sound as distant as they do. But the overall feeling is one of a unique and perceptive work that draws from almost forgotten musical traditions.

John Diliberto

Sound: B-

Performance: A

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Bayou Lightning: Lonnie Brooks Alligator 4714, stereo, \$7.98.

On **Bayou Lightning**, Lonnie Brooks serves up a potent fusion of urban blues, rock 'n' roll, soul and a variety of Southern R & B influences that fall under the catchall word "funk." Twenty years of club work in Chicago, preceded by a brief stint as Deep South rock 'n' roller Guitar Jr., have helped Brooks become an extremely polished and versatile bluesman: His roaring, Little Milton-like voice and strong guitar work enable him to perform credibly in a number of settings.

Bayou Lightning is so polished, however, that the set's grittiest moments strike this reviewer as too calculated to be convincing. *I Ain't Superstitious*, the oft-recorded Willie Dixon classic, is typical of Brooks' approach to his material: A catchy basic riff, a danceable beat, some powerhouse guitar, but none of the rough edges that grab a listener and keep him coming back again and again. Most of the remaining numbers are originals in which Brooks shows a definite flair for songwriting. His often clever lyrics probably work well in concert, but on disc they sometimes seem overly cute and barely worth all the effort Brooks puts into his energetic vocal delivery.

Once you accept the stylistic differences between Brooks and such rawer, hard-hitting urban bluesmen as Son Seals, however, **Bayou Lightning** mea-



sures up very nicely on its own merits. In fact, one cut is a blockbuster by any standard and just might find its way onto the radio. *Watch What You Got* is the kind of touching soul ballad that seemingly disappeared when Stax folded. Beginning with a simple, yet haunting guitar part and a soft vocal tinged with pain, the song builds repeatedly to scorching choruses before reaching a satisfying fade-out.

Lonnie Brooks has such an enviable reputation in Chicago that blues fans would do well to judge **Bayou Lightning** for themselves. Roy Greenberg

Sound: B

Performance: B

Chaser: John Lee & Gerry Brown Columbia NJC 36212, stereo, \$7.98.

John Lee (bass) and Gerry Brown (drums) are a rhythm team whose presence on any session guarantees that the music will be tight, funky, and predictable. Their solo albums are little different from their session work, as both are variations on a commercial fusion formula with the same interchangeable players. **Chaser** is a mild departure since it reflects Lee and Brown's extensive time in Europe

where they played with Chris Hinze, Philip Catherine, and expatriate Charlie Mariano. The result is the appearance on **Chaser** of three noted Danish musicians, Eef Albers on guitar, Kenneth Knudsen on keyboards and Palle Mikkelborg on trumpet. They are assisted by saxophonist Bobby Malach from Stanley Clarke's band and guitarist Daryl Thompson.

Chaser has a harder edge than most current fusion recordings. There is no denying the rhythm team's drive, but

there is often little to propel here. The melodies are simple, catchy phrases that provide one idea per song. The soloists generally stick close to the melody, especially Malach whose playing is very facile. Albers offers some exciting, if one-dimensional guitar runs that at least have a cutting edge.

There is a raucous energy in this music that lifts it above the mundane, and the production is geared for maximum sonic effect rather than the usual gloss. But it is still a perfunctory recycle.

John Diliberto

Sound: B

Performance: C-



Live, Volume 2: David Murray
India Navigation IN 1044, stereo, \$7.98.

This is the second release of a set recorded at the Lower Manhattan Ocean Club on December 31, 1977. At that time David Murray was making the transition, at the age of 22, from a brash young journeyman into a seasoned explorer. With a group composed of Lester Bowie from the Art Ensemble of Chicago, Fred Hopkins of Air, and Phillip Wilson, Murray was already laying the groundwork for the new sound in jazz that has collective empathy and individual brilliance as its cornerstone.

For *Walter Norris* takes up all of side one. This lengthy dirge meanders through desolate expositions by both horn men. Murray's tenor sax seems to bend notes inside itself in tortured slides that disregard the occasional limitations of his instrument. Bowie's solo echoes this bleakness in a drunken pathos when he staggers across the stage with his open medical coat and stethoscope. Hopkins and Wilson

straggle along as if offering consolation and support.

This group draws much of its inspiration from the early quartets of Ornette Coleman in both instrumentation and structure. *Santa Barbara and Crenshaw Follies* has a call-and-echo head that leads to a headlong plunge of kinetic energy. Wilson's drumming is outgoing and ebullient in a broken field run with his own inner logic. Hopkins pilots his bass as if he were dodging bullets, and Murray and Bowie take contrasting solos. Murray's is a long continuous stream of consciousness while Bowie's is episodic, as

if it were several self-contained short stories.

David Murray is an improvisational giant whose brilliant technique allows him the limitless expression and insight of his own deep-running emotions. *Live, Volume 2* is another arresting chronicle of his adventures with fellow travelers.

(India Navigation records are available from India Navigation, 60 Hudson St., New York, N.Y. 10013).

John Diliberto

Sound: B-

Performance: A-

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Classical reviews

Edward Tatnall Canby



Felix Weingartner/Beethoven. Symphony No. 3 "Eroica"; Leonore Overture No. 2. Vienna Philharmonic (1936), London Symphony (1938). Vox Turnabout THS 65147, mono, \$4.98.

In the later 78 electrical days, Felix Weingartner was one of the big names, for Beethoven, perhaps the biggest. His performance here of the *Eroica* is a marvelously flowing one, somehow fresher and more aware than the mass-production versions we get too often today. In 1936 Beethoven was indeed fresher himself, still the

very king of Romantic music, and this symphony was its very beginning. (He still rates as king, but we are a bit absent-minded about it now; too much else to think about.) Similarly with the rarely heard *Leonore Overture No. 2*, which was the first version of the more famous and much more concise and dramatic No. 3, the one we always hear; Weingartner's No. 2 makes no apologies, so to speak, and thereby comes out the more forcefully.

Sounds to me as though this *Eroica* was made at a concert; it sounds re-

markably modern in the recording, thanks to a very large reverberation—more like that which is normal today than the usual semi-dead sound of the symphonic 1930s. It is that sound of the Grosser Musikvereinsaal in Vienna, fortuitously miked for the 1980s. The sound itself is quite clean and adequately wide range, though as always the louder parts are strained, even at a restricted dynamic range. 1936.

The *Leonore* music was recorded two years later at Abbey Road in London. The sound is much closer and deadier—and, sad to relate, not as clean as the Viennese sound. Not bad, either, just more typically 1930s.

Sound: C+ Recording: B+, B
Surfaces: B

Music of Noel Lee: Caprices on the Name of Schoenberg; Convergences; Dialogues. Noel Lee, piano/harps.; Nouvel Orchestre Philharmonique, Marty; Ole Bohn, vl. CRI SD 408, stereo, \$7.95.

To put the cart before the horse (the music) — if you want the best surfaces from a standard LP anywhere today, try CRI. No extra price, either. This one very nearly rates the ultimate full A, which means not only quiet but with virtually no rhythmic turning sounds.

Noel Lee has been around quite a while as a prodigious and immensely sensitive touring pianist — it seems he has already made some 90 LPs, worldwide, and my attention perked up the instant I saw his name on this album as composer. A first-rate man, representing, in an interesting way, the very last and most homogenized product of the great generations of "modern music" of the first part of this century, from Schoenberg and his followers through Bartok, Hindemith, and the rest — also the famed Nadia Boulanger, French teacher with whom everybody who was anybody just had to study. Noel Lee too, from 1948. Which to an extent dates him. Child of the old greats!

A fascinating record. First side offers a French radio "live" recording of a really big piece, an update piano concerto with Lee as pianist — how often do we hear the composer himself in a major work these days? It is everything that "12-tone" or "serial" means, i.e.

music without a key, based on patterns derived from a tone row, and it is also very much at the mature, sunset end of Romanticism, tempered ever so nicely with what we call "neoclassic" — that is, a bit of humor and once in a while a beat. Quirky. Lee is an expert instrumentalist who knows every instrument's secret desires as well as he knows those of his own piano (and harpsichord on side 2), and he particularly loves the dialogue — back and forth tossings of short bits of music. That, I'd say, is the first appeal of this work and keeps it very alive throughout its uncompromising length. The work is recent, composed from 1973 through 1975, and this was its first performance.

Noel Lee's artistry, especially in the pair of duet works on side 2 (one with harpsichord), is a thing to astonish the ear. Every sound he produces is exquisite, the phrasing, the exact shaping and tone and rhythm of each idea, is that of a great artist — and shows up all too many of our flashier contest winners for their coarseness of thought. *Convergences* for flute and harpsichord came just before the music on side 1 and is similar, again full of interesting dialogue exchanges between two superbly played and very different instruments. *Dialogues* is considerably earlier (1958) and perhaps for that reason is more emphatically neoclassic, with a Bartok-Hindemith cast and a lot of rhythm — yet this also, as per the title, has that fine sense for a dialogue of dissimilar instruments. An incredible delicacy of piano sound, especially the very soft, and a matching violin performance. If you want to hear how music should really be played, try these.

Excellent live recording by the French radio people on the first side with orchestra, and an equally fine, more ambient job of the two pieces on Side 2, derived from a release originally on the Fona label. And note the expert taping and disc cutting — a thousand silences in these dialogues and not a pre-echo or post-echo in the lot.

Sound: A- Recording: A Surfaces: A-

Trio Sonatas by Fasch, Stamitz, Bach, de Fesch. Los Angeles Baroque Players. Crystal S703, stereo, \$7.98.

It's natural that professional "symphonic" players should want to get into solo chamber music once in a while, between orchestral tours, opera, and so on. Here you have four real pros (including harpsichord) who between them seem to have performed in every orchestra from Chicago to L.A.

and back. That, alas, is exactly the way their Baroque (and gallant) sounds. I didn't enjoy it.

Proficient, of course. But hard, not well phrased (the flute is good and so is the harpsichord), and all too often hacked out in a really ugly fashion, bangety-bang. This merely reflects the necessarily narrow, technical-minded background that is a part of this highly competitive and demanding musical trade — who has time to learn styles of Baroque and be a virtuoso too? The sound of this music simply reflects the average conservatory musician's idea of Baroque — they'll do it every time unless somebody tells them no or, on rare occasions, somebody just has a natural feeling and respect for this type of music.

The worst here, actually, is the post-Baroque, the gallant "early-Mozart" style of Karl Stamitz of Mannheim. His frittery stuff, though it can be charming if played with sensitivity and delicacy, is powered right into the ground by these three ladies and one gent. Take it easy, folks — this is *music!* (But I like their slow movements, where the power output is reduced.)

Very loud recording, cut heavily and, I'd say, a bit coarsely. Fits the performance.

Sound: B- Recording: B+ Surfaces: A-

Ve Iss da Mighty Tubadours Ya? Frank Berry, Tim Reilly, David Lusher, Albert Harclerode, Adi Hershko. Crystal S 421, stereo, \$7.98.

Some tubists (as they call themselves — players on the tubes) these days go in for very serious contemporary music and do not like to get made fun of, as I have found to my cost. OK — these boys are just being subversive, I suppose? Upholding the long reputation of the tuba as somehow an innately preposterous instrument, a cross between an elephant and a rhino, or maybe a Volkswagen and a diesel locomotive. That is about the way they sound here, and intentionally so, though the playing is very expert and often musical, according to the subject matter.

The subject matter ranges widely, as they say. Beethoven. Bach. *Mood Indigo* and *Down By the Old Mill Stream*. The fancier the composer, the more preposterous the sound, and I suppose the acme, in this case, is a fat portion of Mozart's *Eine Kleine Nachtmusik!* It's all extremely blatty and burpy and sounds exactly like the title.

Sound: G? Recording: B+ Surfaces: Forgot to notice.

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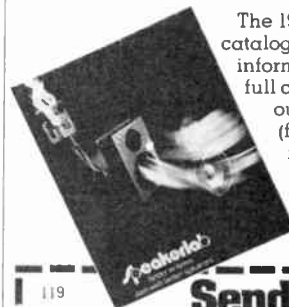
Although of conventional woofer/midrange/tweeter configuration and no costlier than dozens of other medium-sized floor-standing dynamic speakers currently sold to audiophiles, the new system is distinguished by its avoidance of the typical design errors, large and small, that The Audio Critic's comprehensive laboratory tests and listening evaluations have uncovered in all such speakers reviewed until now, even in the recommended models. The resulting sound quality is equaled or exceeded only by the most expensive full-range electrostatics—and not all of them.

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Folk bag

Tom Bingham



sounding piece. It is constructed in a manner derived from the Indonesian practice of having the lower-pitched instruments play the basic theme while the higher pitched instruments elaborate on it at a proportionately quicker tempo, with gongs punctuating the phrases. It unfolds at a very slow, serene pace, becoming brighter, more complex, and faster as the piece progresses. *Circular Thoughts* is a fully convincing example of how traditional structures and tonal combinations can be adapted to contemporary creative ends without damage to either.

Dika Newlin's *Machine Shop* is intended to evoke the sounds and rhythms of a group of workers at machines. While essentially a novelty, it is a successful and ingratiating one. *D.N.A.* by Elena Carey uses the distinctive gamelan timbres to portray mathematical molecular relationships. The result is an enchanting piece with a disarmingly childlike simplicity. Philip Corner's *Gamelan II* uses high-pitched sarons and *bonangs* to derive attractively harmonized tone clusters, arranged in a steady rhythm. About halfway through, the musicians suddenly begin to shout out numbers in a manner apparently patterned after the Balinese *ketjak* monkey chant.

Barbara Benary is represented by two related works. *Braid* is a gentle experiment involving replacement of pitches in a tone row to achieve the effect of a music box in which the melody keeps changing little by little. In *Sleeping Braid*, the tone row becomes a delicate canon, played by sarons and an Indonesian zither (*tjelumpung*).

The recording is comparatively dry, less colorful and resonant than the instruments demand. The editing is amateurish in spots. The pressing of my copy was awful, with skips, gouges, loud ticks, and similar sore spots. (Folkways Records, 43 W. 61st St., New York, N.Y. 10023.) Tom Bingham

Sound: C

Performance: A-

The Rising Fawn String Ensemble: Norman Blake

Rounder 0122, stereo, \$7.98.

Any time Norman Blake puts out an

Gamelan in the New World: Gamelan Son of Lion

Folkways FTS 31313, stereo, \$7.98.

The gamelan is the basic instrumental combination of Java and Bali, consisting primarily of a variety of keyed melodic-percussion instruments (comparable to xylophones) and gongs, occasionally augmented by nonpercussion instruments.

Gamelan ensembles in America have generally played reproductions of Indonesian music. The New Jersey-based Gamelan Son of Lion, however,

has developed a more experimental approach. Although they use the traditional instruments and scales, the group's original compositions are greatly influenced by contemporary chamber music of the minimalist school. The results are not only fascinating in themselves, they open up new possibilities for future creative exploration of non-Western instrumental ensembles.

The longest work, Daniel Goode's 16-minute scalar exposition, *Circular Thoughts*, is also the most Javanese-

Illustration. Rick Tulka

album you can expect some unbelievably fine guitar picking. Here Norman is joined by his wife Nancy on cello and for one track mandolin, and by James Bryan on fiddle. Throughout the set taste is the hallmark, making this one of Blake's finest albums.

Norman Blake doesn't rely on death-defying speed to show off his virtuosity. Instead he plays at a comfortable pace and still is as dazzling as can be. He's not hamstrung by any sense of tradition as he changes keys at will to suit his own purposes on some of the fiddle tunes. And when he writes an original song like *Charlie Gaither* or *Tin Foil and Stroke* he is most likely to celebrate down-to-earth, real people who have the strength to follow their own path in the world.

The work of The Rising Fawn String Ensemble is exemplary on the new album. When music is given respect and love, as it is here, and played this well, the results have to be special. And when the record has been recorded as clean and rich as this one, it is an event not to be missed.

Michael Tearson

Sound: A

Performance: A

Ah! Surely: Eddie Cahill

Shanachie 29014, stereo, \$7.98.

The indefatigable Mick Moloney continues to unearth first-class traditional Irish musicians along the Atlantic coast of the U.S. Eddie Cahill is a Sligo-born flutist who has lived in Philadelphia since 1950. Cahill plays with both exceptional technique and irresistible fervor in a personalized version of the lively, uptempo Sligo style. His embellishment is ornate, yet so quick and clean that it gives his playing a dancing animation which keeps the listener glued to the music at all times. To appreciate how rich and intricate his ornamentations are, compare Cahill's wispy-toned flute curls with Moloney's more straightforward mandolin melodies in their duet arrangement of the reels *The Sailor on the Rock/The Duke of Leinster*.

It's not simply Cahill's ornamentation which makes his playing so exciting. His breathing is so firmly under control that the flow of the music is interrupted only by his sensitive punctuation, which he times so that it always seems to come at the most opportune moments. Only on the jigs *Jim Conroy's/The Boys of the Town* and the hornpipes *Jerry Daly's/Dunphy's* does his blowing seem the least bit unsteady, and then not by much.

What's more, his repertoire steers clear of overworked standbys for the most part; by far the most familiar piece here is the ubiquitous *Miss McLeod's Reel*.

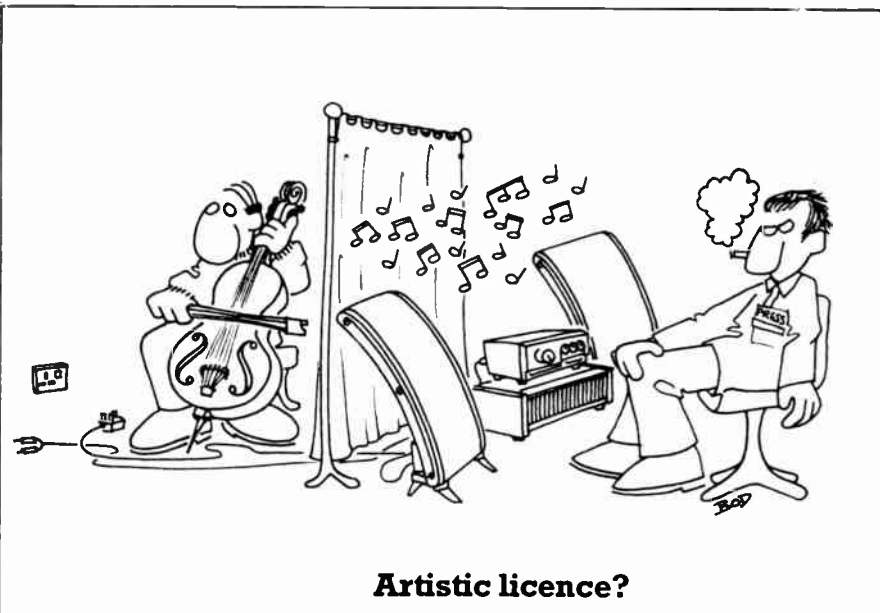
As always, Moloney contributes thoughtfully conceived, skillfully executed, rhythmically alive backdrops on guitar and bouzouki. Certainly he ranks as the most accomplished and inventive accompanist in Irish-American music today, aside from his equally significant roles as record producer, talent scout, and folklorist.

But this is Eddie Cahill's moment in the spotlight, and his playing should do much to increase the popularity of the Irish concert flute in America to even greater heights than it currently enjoys thanks to Cathal McConnell and Michael Tubridy. Without question, **Ah! Surely** is an essential album for lovers of traditional Irish music on both sides of the Atlantic. (Shanachie Records, 1375 Crosby Ave., Bronx, N.Y. 10461.)

Tom Bingham

Sound: B+

Performance: A



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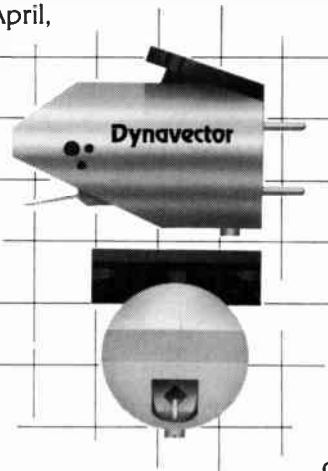
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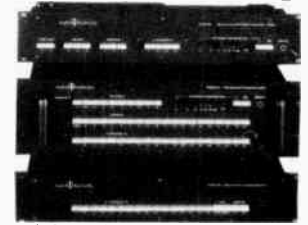
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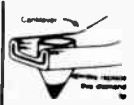
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Parts Two and Three.



TDK's philosophy of constant improvement has brought you the most advanced tape formulation on the market. Yet, the best tape in the world is only as good as the highly complex transport system that guides it past the heads of your deck. So the next parts of our story begin where the tape starts. *Part Two*, the special TDK hub/clamp assembly. And *Part Three*, the leader. TDK discovered that if a hub/clamp isn't perfectly round, the tape gets wrinkled at regular intervals, leading to crinkling and uneven winding. These become problems you can hear. Like wow and flutter, poor head contact, loss of highs and actual dropouts in the music.

These imperfections are exaggerated by second-rate clamps. Some manufacturers jam a pin into a notch to secure the tape. The result is a dip that's passed on through successive tape layers. A hub/clamp assembly off by as little as the thickness of this paper can multiply problems in a dozen layers of tape.

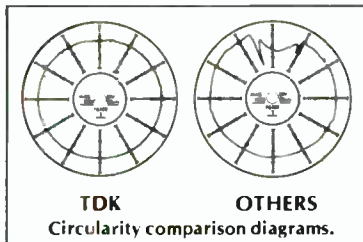
TDK uses computer-designed molding equipment and the very best materials to produce a unique

45° "W" double clamp with a special double purpose. The inner surface secures the leader flawlessly to the hub. The outer clamp section completes the circle, which is then checked for roughness and circularity on a machine that enlarges 100 to 10,000 times. As a result winding is always precise. Tape is off to a smooth start. The colored clamp acts as a moving tape indicator. You'll see tape direction and running stability at a glance.

The high-visibility TDK leader also has a dual purpose. It's matched perfectly to the tape and precisely spliced with a strong adhesive. Its special design protects the tape from stress and doubles as a head cleaner. TDK leader actually cleans recorder heads in a single pass without causing wear. The special timing

marks, spaced exactly one second apart, allow precise cueing.

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There are countless cassette decks to choose from when your object is price. But when your only object is performance, look at the RS-M95 with metal tape capability.

The heart of the RS-M95 lies in its quartz-locked direct-drive capstan motor and its computer-controlled tape tension system. Together, they team up to provide constant tape tension, remarkably low wow and flutter and complete immunity from speed inaccuracy. So when you record an A flat, you'll hear an A flat. No more, no less.

But if more is what you want, you'll get it with metal tape. Because, compared to conventional tape, it gives you a frequency response with more dynamic headroom and more high end extension.

You'll also get the advantage of the RS-M95's three-head configuration: Source/tape comparison. What you don't get is azimuth error, because our HPF record and playback heads are not only precisely gapped, they're also precisely enclosed in a single housing.

To add to the RS-M95's three-head configuration, we added double Dolby*. So you can monitor your tapes with the full effects of Dolby noise reduction.

Another glowing feature of the RS-M95 is its two-colored fluorescent (FL) bar-graph meters. They're fast, thanks to a device attack time of just 5 millionths of a second. And accurate, thanks to a Technics high-slew-factor operational amp for absolute wave and peak detection.

Also included are 4-position tape selectors with bias fine adjustments. A built-in 400 Hz/8 kHz test tone oscillator. A separate, coreless DC motor for reel drive. A microprocessor tape counter with triple memory functions and feather-touch controls.

Technics RS-M95. Its performance is its only reason for being.

FREQUENCY RESPONSE (Metal): 20-20,000 Hz (± 3 dB). WOW AND FLUTTER: 0.03% WRMS. S/N RATIO (Dolby in): 70dB. SPEED DEVIATION: $\pm 0.1\%$.

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