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THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • JUNE 1978 $1.25

47425

Dolby Kit—Part II

The Ultimate Turntable?

New IHF Amp Standard

Disco Scene –'78

Most companies would consider a receiver with any one of these innovations remarkable.

But Pioneer isn't just any company. And our 270*watt SX 1980 is somewhat better than remarkable.

Every month, somebody introduces something called "the world's most incredible hi fi receiver."

Yet when you compare their features and technology to Pioneer's SX1980, these "miracles of modern science" begin to look, and sound rather pedestrian.

The greatest DC power story ever told.

It's a simple fact of life that the more pure power a receiver possesses, the easier it can reproduce music without straining.

And at 270 watts per channel, even the most demanding piece of music will hardly cause the SX1980 to flex its considerable muscle.

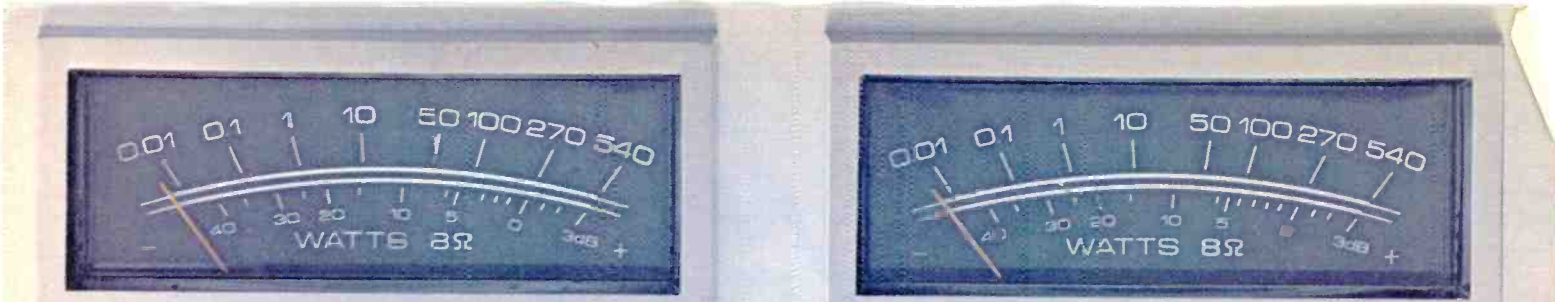
But when we built the SX1980, we did more than just create an incredibly powerful receiver. We created a whole new high powered technology.

Each channel, for example, has a separate DC power configuration that helps to provide richer and more accurate bass.

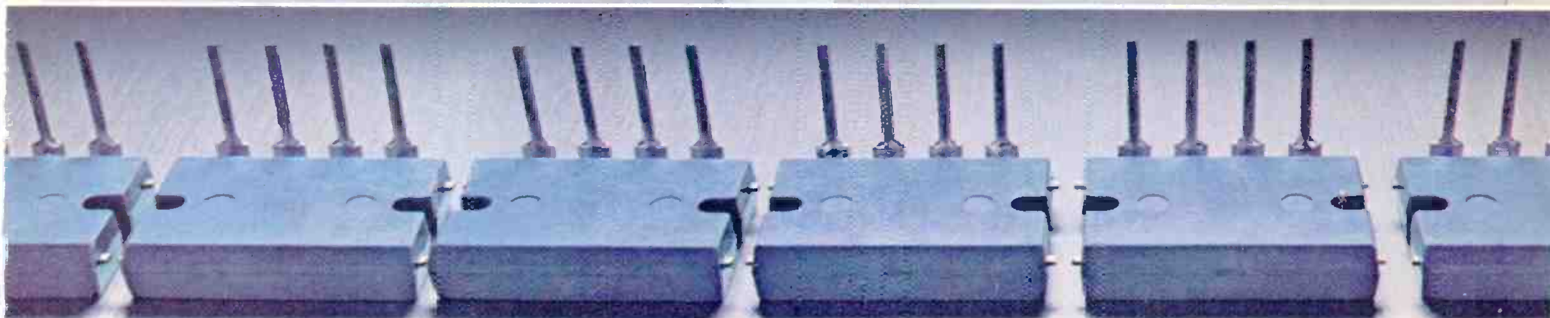
Where some high powered receivers try to get by with ordinary transformers, Pioneer has developed a 22 pound toroidal core transformer that's far less susceptible to minor voltage variations. So you get cleaner, clearer sound.

And instead of pushing conventional power transistors to their limits (the way some manufacturers do), we've actually invented new transistors that last longer and eliminate the need for fans that can cause electrical interference.

All told, these innovations give the SX1980 a total harmonic distortion level of less than 0.03% from 20 to 20,000 hertz. A figure that not only taxes the imagination, but also the abilities of most scientific

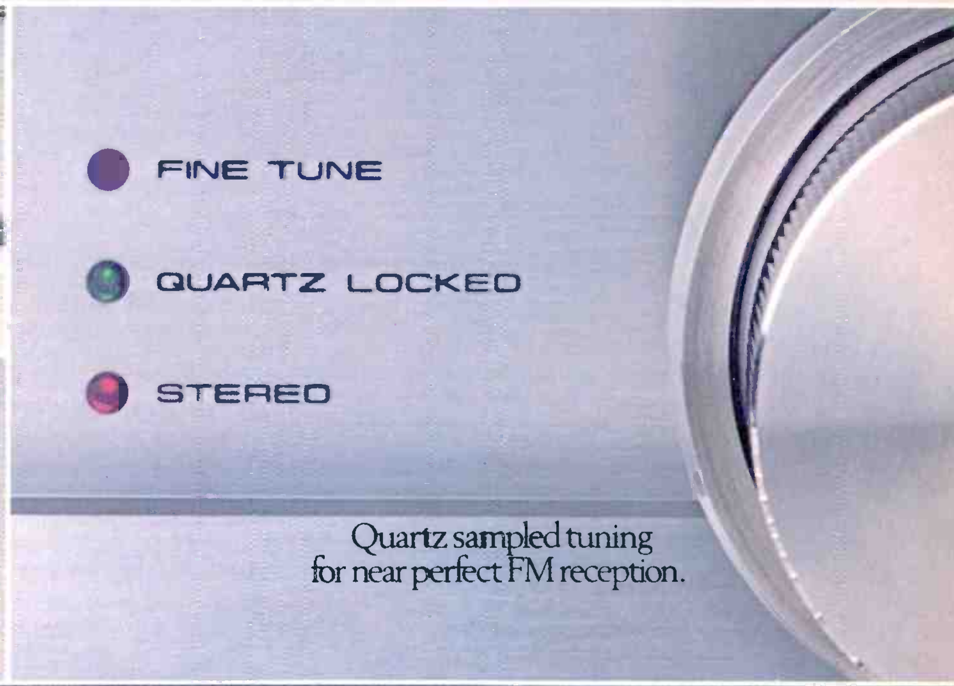


Wattage meters that let you see what you're hearing.


High powered transistors that don't need fans.

Impedance switches that let you get the most out of your cartridge.

3,000 different combinations of tone.



Quartz sampled tuning for near perfect FM reception.


A power section that puts out a continuous power output of 270 watts per channel from 20 to 20,000 hertz with less than 0.03% total harmonic distortion.

Audio

June 1978 "Successor to RADIO Est. 1917" Vol. 62, No. 6

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About the Cover: With the rapid advances in audio technology, it sometimes seems we're living in a Dali-esque fantasy land. For a glimpse at the possible future of turntable technology, see the article starting on page 78. Photo by: Photographic Illustrations Ltd.

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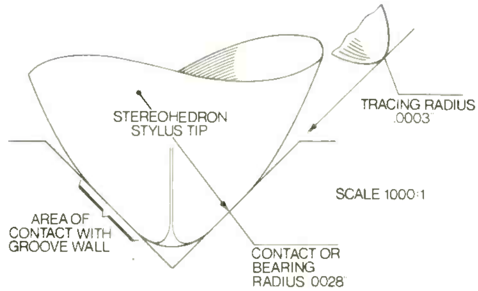
The XSV/3000 is the source of perfection in stereo sound!

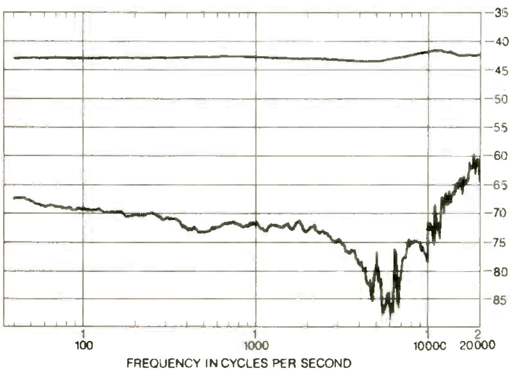
Three big features . . . all Pickering innovations over the past 12 years . . . have made it happen.

1976: Stereohedron® This patented Stylus tip assures super-traceAbility™, and its larger bearing radius offers the least record wear and longest stylus life so far achievable.

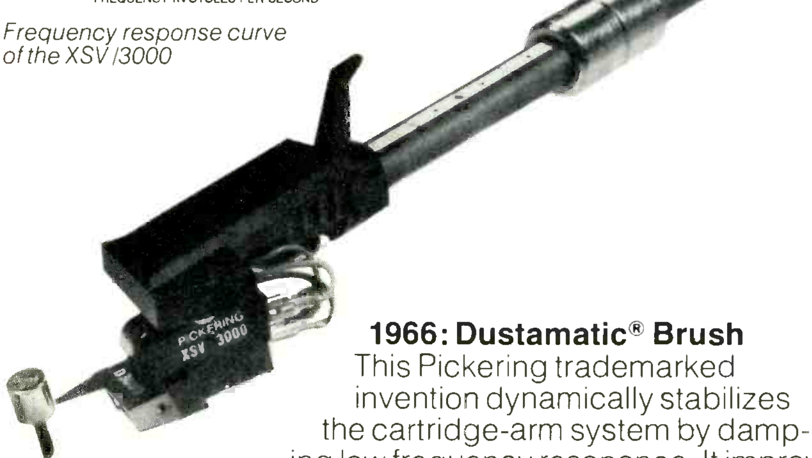


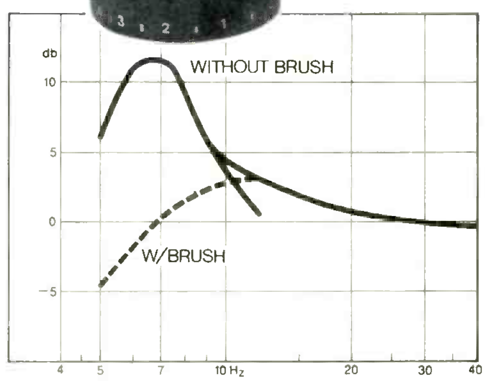
Technical drawing of the Stereohedron shape

1975: High Energy Rare Earth Magnet
Another Pickering innovation, enabling complete miniaturization of the stylus assembly and tip mass through utilization of this type of magnet.



Frequency response curve of the XSV/3000





Damping effect on tonearm resonance

1966: Dustamatic® Brush
This Pickering trademarked invention dynamically stabilizes the cartridge-arm system by damping low frequency resonance. It improves low frequency tracking while playing irregular or warped records. Best of all, it provides record protection by cleaning in front of the stylus.

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The Quest for Perfection. At $200, the Micro-Acoustics 530-mp offers the same patented* direct-coupled transducing system as our other highly-praised stereo cartridges. The same twin-pivot design, for superior transient ability. The same dual-bearing construction, for outstanding tracking ability. The same built-in microcircuit. And, like the 2002-e, the same super-light beryllium cantilever and low-mass design. Plus more.

For those very few people whose pursuit of perfection overrides everything else, the 530-mp offers two subtle refinements not found on our other cartridges.

But the improvements these refinements provide can be realized only on a system representing, at the very least, an investment of $3,000 in turntable/tonearm, preamp, amplifier and speakers. And even then, only by individuals with the most discriminating ears. In other words, less than 2% of component high-fidelity system owners.

An Analog Stylus. The new 530-mp features a Micro-Point™ playback stylus. It is an exact analog of our Micro-Point recording stylus, used to master over 500,000,000 of the world's best stereo discs this year. By replicating the recording stylus geometry, the 530-mp stylus provides optimum groove contact. The result is unsurpassed definition.

Graphic Recorder
Plotting of individual 530-mp frequency response.

V-groove Lapidary
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Individual Curve. Like our other cartridges, each 530-mp undergoes numerous demanding QC tests, monitored by sensitive electronic equipment. In addition, each 530-mp must run the gauntlet of further tests, culminating in an individual frequency response curve. After checking and initialling the curve (which is then packed with the unit), the senior quality inspector serializes the cartridge and approves it for shipment.

$3,000 Later. With all these refinements, however, the sonic difference between our top-rated 2002-e and the new 530-mp is admittedly very subtle. (In fact, for most applications, the 2002-e is all you'll probably ever need.) But if you've invested $3,000 or more in state-of-the-art equipment, subtle differences are obviously important to you. Important enough to audition our 530-mp.

For more information and the name of your nearest dealer, please write or call: Micro-Acoustics Corporation, 8 Westchester Plaza, Elmsford, NY 10523 (914) 592-7627. In Canada, H. Roy Gray, Ltd., Markham, Ont.

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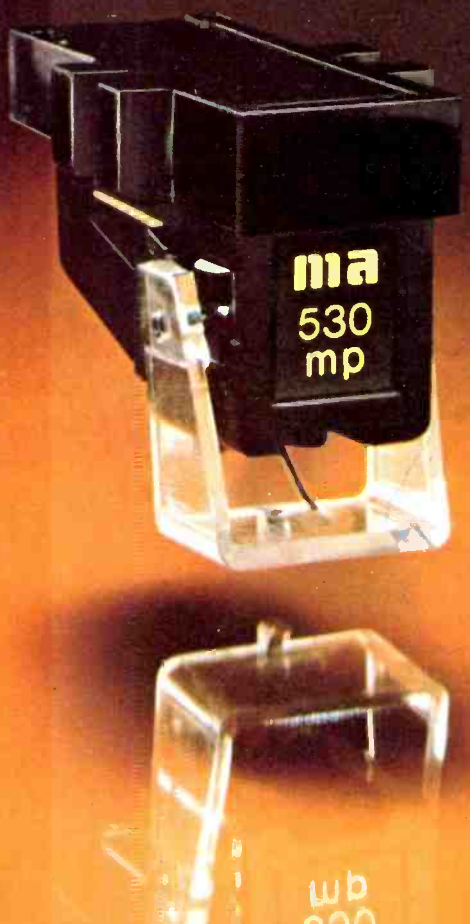

*U.S. Pat. #3952171

Audioclinic

Joseph Giovanelli

Graphic & Parametric Equalizers

Q. Describe and define the difference between graphic and parametric equalizers. What is the advantage of each of these devices?—Martin Smith, Grants Pass, Oreg.

A. A graphic equalizer divides the audio spectrum into many separate slices, and because of the arrangement of the controls, you can see at a glance what the frequency response is. The controls are essentially a graphic representation of the frequency response produced by the equalization you have selected.

With a parametric equalizer the spectrum is also divided into sections, and there are usually not as many controls for accomplishing this as are found on a graphic equalizer. Where a good, one-octave graphic equalizer will have 10 sets of controls, a parametric equalizer might only have four sets.

With the graphic equalizer, the controls boost or cut at the frequencies shown as well as some distance above and below these designated frequencies. The controls on parametric equalizers have three different capabilities. First, associated with each frequency control is another control which can shift the center frequency over some given range, perhaps one octave in either direction; this means that we can either use the controls as marked or shift their operating frequency range. This means that a few boost and cut controls can do the work of many. The philosophy behind this is that, in compensating for room acoustics, defects in recording quality, etc., it is probably necessary to only touch up about three or four points in the audio spectrum.

Another control associated with each boost and cut control is a *Q* control. What this does is to adjust the bandwidth covered by the selected boost and cut. The conventional graphic equalizer is arranged so that all boost and cuts cover a specific bandwidth. However, the parametric equalizer is arranged so that the bandwidth can be made either very sharp or very wide, depending upon whether the sound corrections require a narrow notch of correction or a broad, smooth slope.

The one-octave graphic equalizer can be operated with excellent results with only a little practice by most users. The parametric equalizer, on the other hand, will take some getting used to, but once mastered, provides a degree of control not possible with a graphic equalizer.

Matching Output Tubes

Q. I have a vacuum-tube amplifier. The instruction manual specifies that the output tubes should be replaced with matched pairs only. Can you please tell me how I can match tubes myself?—Name withheld.

A. It is best to use a mutual conductance tube checker to match vacuum tubes. The tube checkers usually found in stores only check cathode emission, and this is only one parameter of tube operation. Mutual conductance is also important in achieving a proper match.

Some tubes are sold in what are, at least, said to be matched pairs. These are more expensive than buying two loose single tubes with the hope that they will properly match up. I have seen cases, however, where the match of a pair was not too well made.

The need for matched tube pairs is less in an amplifier which has a means for adjusting both bias and a.c. balance. The bias adjustment should be so arranged that it can be set up for each tube individually, rather than for the pair of tubes only.

Drum Miking

Q. I play drums with a few groups and I tape record all our sessions. Could you tell me what type of mikes are best for recording the drums?—Steve Johnson, Paulsboro, N.J.

A. You need mikes with a good low-frequency response. Probably, they should be omnidirectional to pick up the reverberant as well as the direct sound. You probably will want the microphone to be sturdy, which seems to call for a dynamic.

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

Soundcraftsmen new class 'H' 250 w. amplifier

TEST REPORTS PRAISE IT ▶ *"Incredible Dynamic Headroom into 4 ohms"... "Transparent, uncolored sound"... "Outstanding amp"...*

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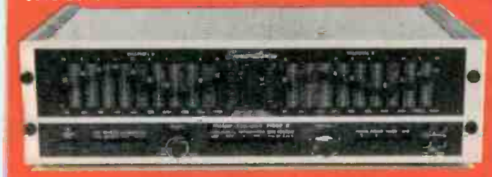
GUARANTEED SPECIFICATIONS ▶ ***250 WATTS RMS PER CHANNEL, 20 Hz-20 KHz, BOTH CHANNELS DRIVEN INTO 8 OHMS, 0.1% THD... FANTASTIC DYNAMIC RANGE (HEADROOM) INTO 4 OHMS... T.I.M. <0.02%... S/N >105dB. DAMPING FACTOR >100... SLEW RATE >50... FREQ. RESP. ± ¼ dB 20-20 KHz.***

MATCHING PREAMP-EQUALIZER



Now the PE2217, rated "State-of-the-Art" and "Best-Buy" in magazine Test Reports, is available as the PE2217-R in rack silver-black form as a matching mate for our new amplifier. With the control flexibility of pushbutton-patching for tape monitoring and tape dubbing between two or three machines together with tape and program discrete-octave equalization, the PE2217-R is still the MOST POWERFUL and FLEXIBLE Preamp available at $549.00

VARI-PORTIONAL SYSTEM® — TECHNICAL DESCRIPTION: A brief explanation of the VARI-PORTIONAL® SYSTEM is that its computer-like ANALOG LOGIC CIRCUITRY senses and calculates the amount of voltage required in accordance with the amplifier's rising or falling output power level, and it then directs the power supply to make available precisely the amount of voltage required, with no wasted energy. The 'scope photo illustrates this Patent Pending system by showing a loud rock music signal penetrating the upper voltage supply and also showing the supply **VARIABLY** increasing **AHEAD** of the signal.

VARI-PORTIONAL® CIRCUITRY-BENEFITS:

a. enables 350 watts at 4 ohms, 250 watts at 8 ohms, at very low cost.
b. reduces AC line current requirement to save 1 kilowatt every 5 hours, yet provide full power whenever needed for high level output.
c. combined with ultra-fast output circuitry, provides extremely low T.I.M. for clean undistorted sound, with a **SLEW RATE** of better than 50 volts per microsecond, for exceeding most other amplifier circuits.

VARI-PORTIONAL® L.E.D.'s: When either channel's output level reaches approximately 50% of total power, the green L.E.D. will start to flash. It is indicating that the ANALOG LOGIC CIRCUITRY is actuating the second power supply, a VARIABLE high voltage supply, and the A.L.C. is controlling that supply's voltage IN ANTICIPATION of a potentially higher output level requirement. The L.E.D. will glow proportionally brighter, showing the voltage supply increasing, as the metered power output rises above approximately 50%. When the green L.E.D. is NOT ON, the low voltage power supply is in continuous operation, and the amplifier is operating in its most efficient mode, drawing very little AC line current and therefore saving energy costs (for example, you save approximately 1 kilowatt every 5 hours over a conventional Class B or AB amp, both operating at ⅓ power).

CLIPPING INDICATORS: The red L.E.D.'s, indicating clipping, are able to respond to signals much faster than meters can, and the clipping lights will flash dimly as clipping begins. When the clipping lights are bright, the amplifier is exceeding its rated power output. (Clipping will occur at varying power levels, from somewhat over 250 watts at 8 ohms, to over 350 watts at 4 ohms.)

3 models, Power Amp, Meter Amp, Amp-Qualizer® priced from $599.

"AUTO-CROWBAR®" INSTANTANEOUS OVERLOAD PROTECTION: This Soundcraftsmen AUTO-CROWBAR® protection circuitry is unique among amplifiers. It uses no relays, no circuit breakers. AUTO-CROWBAR® circuit will automatically and continuously attempt to reset itself every second or two, until the overloaded condition is removed.

NON-LIMITING CIRCUITRY protects speakers from limiter-caused distortion that results from overdriving in amplifiers that use current-limiting circuitry.

DIRECT-COUPLED output.

SPEAKER-PROTECTING input circuitry with automatic blocking of input below 1 Hz. This prevents DC from any input source from blowing out speaker cones.

CERTIFICATE OF INSPECTION: Actual measurements of each unit are enclosed with each unit to show actual measured rms output per channel, actual measured distortion per channel, actual measured slew rate per channel, etc.

REMOTE TURN-ON TRIAC-ACTUATED delay circuit eliminates turn-on surge at time of switch closure, enables **REMOTE** AC turn-on plug-in for switching from your preamp.

INPUT LEVEL CONTROLS: The input level controls are designed to assist in system operation by providing input voltage control from 0 to full. This capability is particularly valuable in public address, sound reinforcement, and amplified musical instrument applications where many long cables are in use and where ground loops and other unwanted conditions might exist.

METER RANGE: When the meter range "times 1" (X1) button is depressed, the meter will indicate approximate power output in percentage (100% = 250 watts, assuming an 8 ohm load at the speaker output terminals).

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Audio etc.

Edward Tatnall Canby

The following will diverge from the purest audio but, all in due course of time/space, will work around to that proper subject. So hang in there with me! Do you remember Aunt Minnie?

She was no joke, nor is this. A generation ago, Aunt M. was that dizzy dame who had to have the simplest facts of early hi fi explained for her infinitesimal intelligence, so that she could play music all by herself without being electrocuted or something. I fear we writers ran her right into the ground for awhile. Quite sadistic. No doubt we all had our own Aunt Minnies, under a different name, somewhere in our own plaguy lives. Frustrating.

So now I feel frustrated and I'm bringing her back, if for a different purpose. I need her to help me defend—phew!—the very basis of our civilization and, incidentally, of audio. We do live in the d—dest age. We see the most extraordinary development of technology ever—in every imaginable field including our own—fairly bursting, blasting forward. And yet at the very same time we can see the dimming everywhere of what can only be rightfully called the method of science. Help, Aunt Minnie!

Too many of us, in various ways, in engineering, in the arts, and the philosophies alike, simply do not understand (and often do not respect) the fundamentals of that method, which is never based on mere "facts," nor on the opposite, various divinations, inspirations, hunches, vibrations, oneness with nature, and the cosmos—but rather on a very rigorous *combination* of these. It is a starkly demanding discipline, this scientific method, as every good engineer knows, and on earth only man has had the intelligence, the brain, body, and memory by which it can be made to operate. But man is millions of years old and scientific method is far less than a thousand. We can lose the whole thing in a mere blip of time, and so lose our world, good and bad; since what we have is built strictly upon the method of science . . . but enough. You can't even build a phono cartridge without scientific method.

So you remember Aunt Minnie? Good. Well, right now, great-Aunt M. (this is fiction and any resemblance is simply a resemblance) has moved into a ground-floor room, well away from our hi fi and the TV, where we can keep an eye on the old gal. Like so many old people (is *this* modeled on life!), she sometimes just wanders off and we have to retrieve her. Great-aunt Minnie thinks the hi fi is too loud (you remember she never could stand music louder than—well, a radio) and she can't stand TV. Too flickery for her glasses and why are people's heads so pointy? And the sound is so bad—her bone conduction won't take it. Also, she has a strange aversion to purple people, the kind you see smiling in the commercials. If you really want to know . . . she prefers them lemon yellow.

Minnie Maneuvers

OK, here's the proposition . . . great-aunt Minnie has got out again. Just quietly disappeared. Where has she gone *this* time? Have to get her back quick before she comes to harm. So do we sit down and await an inspiration? More likely (now you understand), we apply some quick and practical *scientific method*. It really is the most reliable and fastest way of getting through this sort of problem.

Not "facts" . . . we have none. But we do have a lot of provisional info, and we immediately set up two hypotheses—working assumptions. Sometimes, the old lady just goes out to the movies. Buries herself in a nice, comfortable chair in the middle of all those interesting anonymous bodies and absorbs the big, gentle sound and the vast, large-screen pictures, and not a purple people in sight. So Minnie just might be sound asleep at the movies.

But there is Hypothesis #2. Not a fact, but a tendency. Once in awhile our great-aunt just ambles around the block at full speed, one step per sec. x 4, to visit with her oldest friend, aunt Maxie. Now Maxie isn't really an aunt, but proper scientific approach says that this is irrelevant. So maybe Minnie is with Maxie?

Science, though, says it is not yet a closed thing. There are also *n* other hypotheses, including the one that states she *may* have been run over by a horse and is now in intensive care at one of three possible hospitals. One keeps one's scientific mind open to *all* possibilities, no matter how remote.

It is lucky that Pa Bell invented his telephone. For in great-aunt Minnie's case, unlike many of much greater import, we can check things out quickly. Which hypothesis would you check

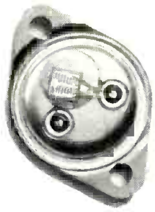
PHASE LINEAR SETS THE STANDARD FOR HIGH POWER.

Current loudspeaker design theory takes for granted the availability of a high power reserve. An idea once considered frivolous by many. Today it is considered essential for the best possible reproduction of recorded material.

To reproduce a musical peak, a loudspeaker requires up to 10 times the average power being delivered. If the amplifier lacks a sufficient power reserve, it will clip, producing distortion and audibly destroying sonic quality.

The Phase Linear Dual 500 Series Two Power Amplifier is capable of delivering 505 watts per channel from 20Hz-20kHz into 8 ohms, with no more than 0.09% Total Harmonic Distortion. That's unsurpassed power for unsurpassed realism.

CONVENTIONAL OUTPUT TRANSISTOR.



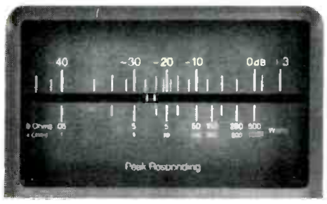
DUAL-500 OUTPUT TRANSISTOR.

The Dual 500 utilizes an advanced design in output devices to overcome the problems associated with amplifier clipping at realistic listening levels. As a result, the power handling capability is greatly improved. In fact, the power semiconductor complement of the Dual 500 features the highest power handling capability in the audio industry.

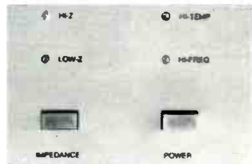
A massive rear mounted extruded aluminum heat sink assembly protects the 36 output devices against overheating and includes a self-contained, thermally activated forced

air cooling system. You don't have to worry about over-heating under normal operating conditions.

Instantaneous indication of output activity is easily maintained with an exclusive 32-segment LED display,



while a special 4-segment clipping indicator warns of hazardous overloads. High/Low Impedance Operation modes are automatically, or manually activated for increased amplifier efficiency when using low impedance speakers.



HEARING IS BELIEVING.

See your local Phase Linear dealer for the most powerful argument for the DUAL 500: a demonstration.

SPECIFICATIONS

OUTPUT POWER: 505 WATTS MINIMUM RMS PER CHANNEL 20Hz-20,000Hz INTO 8 OHMS, WITH NO MORE THAN 0.09% TOTAL HARMONIC DISTORTION.

CONTINUOUS POWER: 1000Hz per channel, with less than 0.09% Total Harmonic Distortion:
8 ohms - 600 watts
4 ohms - 800 watts

INTERMODULATION DISTORTION: 0.09% Max (60Hz: 7kHz = 4:1)

DAMPING FACTOR: 1000:1 Min

RESIDUAL NOISE: 120uV (IHF "A")

SIGNAL TO NOISE RATIO: 110dB (IHF "A")

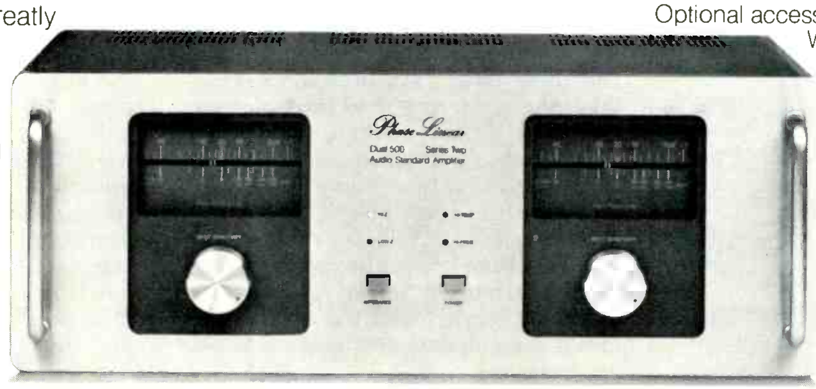
WEIGHT: 65 lbs. (32 kgs.)

DIMENSIONS: 19" × 7" × 15" (48.3cm × 17.8cm × 38.1cm)

Optionally available in E.I.A. standard rack mount configuration.

Optional accessories: Solid Oak or Walnut side panels.

AGAIN.



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first? Of course—aunt Maxie. (Or would you go out looking for a runaway horse?) There she is! You can come and get her any time, says Maxie brightly. End of story.

Shrewd Hunch

Except to note that what turned out-to be a fact was previously NOT A FACT, only a hunch based on shrewd projections. That's science. More often than not, we *can never check* our hypotheses as facts. We can do no more than move forward, bit by bit. So, has our life developed.

Suppose (to get another brief story off my chest, this one true), you were that cunning British criminal back in the early 19th century who set up a most ingenious hypothesis, that if he could jump straight onto that new marvel called a train of cars on a railroad he could fly (almost) from the distant scene of the crime and conveniently vanish in London. A clever idea, all things considered as they then were, but alas it turned out to be faulty. Imagine his surprise when he was met at the London terminal by the criminal authorities, who swallowed him up on the spot.

The scientific hypothesis is always projected from *available* information and, even in the most precise engineering, must be understood to be incomplete, just possibly having missed out on some of the facts. There is no perfect hypothesis! That, in varying degrees, is what scientific method is all about. Our criminal gentleman, unfortunately, did not know that the very first operating British telegraph line just happened to stretch alongside the railroad of his choice. (If he had known this, he might still have altered his hypothesis to include a different railroad and thus have proved it a very fine hypothesis indeed.)

Speaking of criminals, I've been reading three books simultaneously, one on audio and two definitely not, and these three have in fact sparked these thoughts. Not Sherlock Holmes, but Doyle's "Dr. Challenger" series, another craggy character. Doyle and H. G. Wells (and Jules Verne in France) invented that superb literary art called *sci fi*, or science fiction, and nowhere is its methodology better suggested than by Holmes himself. *Sci fi* is, you see, an ingenious playing with the very basis of scientific method and, as many people have observed, it is really almost identical in its approach, "facts," hunches, hypotheses, and all. Look at what those old boys perpetrated on the hunch basis! Submarines, moon shots, time warps (The Time Machine—one of Wells' best), and more. In *sci fi* the hunch comes first, the facts are made to fit. It's fiction, after all. But for every clean shot at the future, right on target, there are plenty of ridiculous misses, just awful from our later point of view, but great fun to read.

Isn't this exactly what happens in real scientific life? We are still making ridiculous mistakes, as our descendants will know. Our methods aren't rigorous enough sometimes and then we crash. Engineering itself, audio development, is not different. We crash, too. Like the diamond stylus that fell out of my cartridge today right in the middle of a record. Not envisioned by the design projection. But we move forward by *not crashing*. It's a rigorous discipline and we must never lose it.

Doyle was a curious man of science. His "The Lost World," a story involving a fictional Amazonian plateau where by a freak of evolution (a hot subject in Doyle's heyday!) all sorts of monsters from the remote past still lived on, is one of the finest *sci fi* stories ever and astonishingly close to later information as it has subsequently developed. Take the sub-human ape men in the trees who battle it out with little brown "indians" down below, smooth skinned and of larger cranium; Richard Leakey, of the Leakey family that has been digging up proto-man in Africa complete with newly accurate datings, now hypothesizes that indeed earlier type and later man species did live simultaneously in the same territories and time. (Leakey is my second non-audio book.) A near-fact, getting nearer, but in Doyle's imagination it was merely an accurate scientific hunch. Charles Darwin, well over a century ago, theorized that man must have originated in Africa, based on sheer reasoning, minus facts. Long after that hypothesis, the Leakeys have shown that this, too, is a near-fact.

Spiritualistic Sophistry

A. Conan Doyle brings *Pithecanthropus erectus*, an apish man, into another of his stories but there we run into a Doylian snag. Doyle was a Spiritualist, Phase I, the Dead Brought Back. His ape man is made of ectoplasm recreated by a human medium. Conservation of energy! Doyle explains that to make this ectoplasm really drains a human medium—it takes work in the strict engineering sense. You can't make something from nothing, after all. Strictly scientific and the only unproved aspect of the hypothesis is the ectoplasm itself, in which Doyle firmly believed. Alas, he "proved" its existence the wrong way, by simply stating that it was so. Even in

"The Sansui AU-717 is a superb amplifier. We like it with no ifs, ands, or buts." (Julian Hirsch) It offers "as much circuitry sophistication and control flexibility as any two-piece amplifying system."

(Len Feldman)

Everyone says great things about the new Sansui AU-717, but the experts say it best.

The Sansui AU-717 DC integrated amplifier is "Sansui's finest .... It incorporates a fully direct-coupled power amplifier section whose frequency response varies less than +0, −3dB from 0Hz (D.C.) to 200 kHz. The amplifier's power rating is 85 watts per channel (min, RMS) from 20 to 20,000Hz into 8-ohm loads, with less than 0.025 per cent total harmonic distortion ..... If any amplifier is free of Transient Intermodulation Distortion (TIM) or any other slew-rate induced distortion, it is this one .... The slew rate ... was the fastest we have measured on any amplifier, an impressive 60 V/usec.

"The preamplifier section of the AU-717 .... has very impressive specifications for frequency response, equalization accuracy, and noise levels ... The AU-717 has dual power supplies, including separate power transformers, for its two channels ... [and] exceptionally comprehensive tape-recording and monitoring facilities .... Good human engineering .... separates this unit from some otherwise fine products ....

Julian D. Hirsch, Contributing Editor Stereo Review

"The Sansui AU-717 is a superb amplifier. We like it with no ifs, ands, or buts." [Reprinted in part from Julian Hirsch's test report in **Stereo Review,** February, 1978.]

"One clear advantage of DC design is apparent. Even at the low 20Hz extreme, the amplifier delivers a full 92 watts — the same value obtained for midfrequency power — compared with its 85 watt rating into 8 ohms....

Leonard Feldman, Contributing Editor Radio-Electronics

"The equalization characteristic of the preamplifier was one of the most precise we have ever measured, with the deviation from the standard RIAA playback curve never exceeding more than 0.1dB......

"Sansui claims that this unit has reduced transient intermodulation distortion — a direct result of the DC design, and, indeed, the model AU-717 delivered sound as transparent and clean as any we have heard from an integrated amplifier....

" ... worth serious consideration — even by those who prefer separate amplifiers and preamplifiers." [Reprinted in part from Len Feldman's test report in **Radio-Electronics,** January, 1978.]

Listen to the superb sound of the Sansui AU-717 at your Sansui dealer today. And be sure to ask him for a demonstration of the matching TU-717 super-tuner.

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audio we sometimes do that little trick.

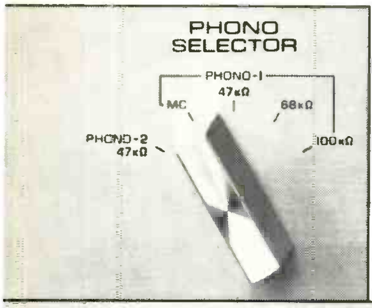
Doyle went off into the beyond firmly intending to return as ectoplasm. He also, I might note, went along with a much more reasonable assumption of the scientists of his time, that there was an all-pervasive substance, without form or shape or mass, which nevertheless infused the universe—ether. Now that was a true and helpful concept in scientific method, a projection, a hypothesis, that could explain things otherwise then inexplicable. In the end, it became outdated and was retired (now we have neutrinos, quarks, cosmic rays, and a batch of other useful and partly factual things to replace it)—but Doyle wrote a story in which an interplanetary belt of *ether* passes across the earth and knocks all living things senseless, seemingly dead. Marvelous descriptive writing, but a false premise. The *ether* passes on and everybody comes alive again. So much for *sci fi.*

Scientific Methodology

Audio? My third book, right along with Doyle and Leakey, has been a splendid manual on the specific designing of a new-generation phono cartridge that came to me from Shure, where the the papers were presented early this year at a seminar (see *Audio* May, 1978, pg. 32). You'd be amazed how neatly these three volumes complement each other. Shure's exposition has had me really delighted (as has a very different JVC seminar report of the same sort)—for if ever there was clear, well-organized scientific method applied to one highly specific subject, it is here, described on paper for the benefit of both engineers and the intelligent press. We follow step by step, through the background "facts," the balances, contradictions, and trade-offs, gathered up one by one, neatly isolated for study, then put together step by step, for the solution of this one, single engineering project. (JVC, differently, covers a wide spectrum of projects.)

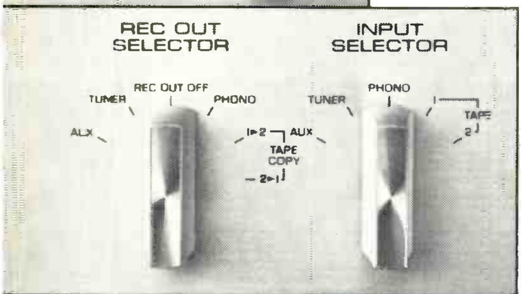
True, the result of the "hypothesis" is a commercial phono cartridge, the Shure V-15 Type IV, and this is Shure's special thinking, not necessarily 100 per cent acceptable to other good cartridge engineers. But if we understand that proper science and engineering ALWAYS leave room for doubt, for correction and change after argument, for adapation and improvement, then-these papers make a remarkably fine example of the right way to think things through, in a crazy, impulsive world. Congrats! And I'll be sure to tell Minnie and Maxie all about it.

The one alternative to separates: The Yamaha CA-2010 Integrated Amplifier.



The Head Amplifier. Discerning music lovers all over the world are discovering the transparent highs and extended frequency response of the moving coil phono cartridge. While other manufacturers require the addition of an expensive preamp or step-up transformer to boost the low output signal, Yamaha included a special head amplifier in the CA-2010. It's available with the flip of a switch on the front panel. And to help you get the most out of moving magnet cartridges, there's a 3-position phono impedance selector.

The Preamplifier. To assure exact, repeatable bass and treble settings, the controls are precision calibrated in ½dB steps. Dual turnover frequencies for both ranges double the versatility of these accurate tone controls. Completely independent Input and Output Selectors let you record one source while listening to another. And the power meters are easily switched to REC OUT readings in millivolts, so you can monitor the actual output level to your tape deck for cleaner, distortion-free recordings.



The Power Amplifier. 120 watts RMS, with no more than 0.03% THD 20Hz to 20,000Hz into eight ohms.

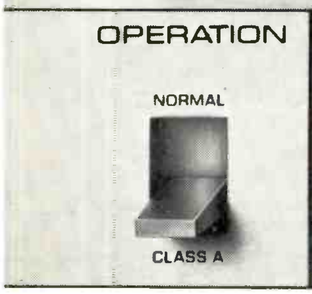
For tighter, cleaner bass response, the amplifier can be switched to DC operation.

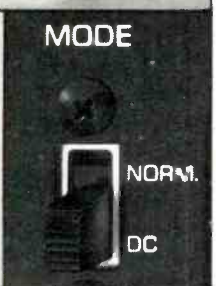
Class A operation is switchable on the front panel, delivering 30 watts RMS, with no more than 0.005% THD 20Hz to 20,000Hz into eight ohms.

The twin power meters are fast-rise, peak delay—they can track even the briefest of transient bursts. Plus they can respond to levels from 1mW to 316W (into eight ohms).

Real Life Rated.™ The specifications of the individual components of the CA-2010 are superior to many separates. Individual specifications alone, however, can't possibly reflect actual in-system performance. That's why Yamaha measures overall performance from phono in to speaker out, rather than at designated points along the signal path. Furthermore, we measure noise and distortion together over a broad output range, rather than individually at the optimum output.

Our Real Life Rated measurement is called Noise-Distortion Clearance Range (NDCR). On the CA-2010, NDCR assures no more than 0.1% combined noise and distortion from 20Hz to 20kHz at any power output from 1/10th watt to full-rated power.





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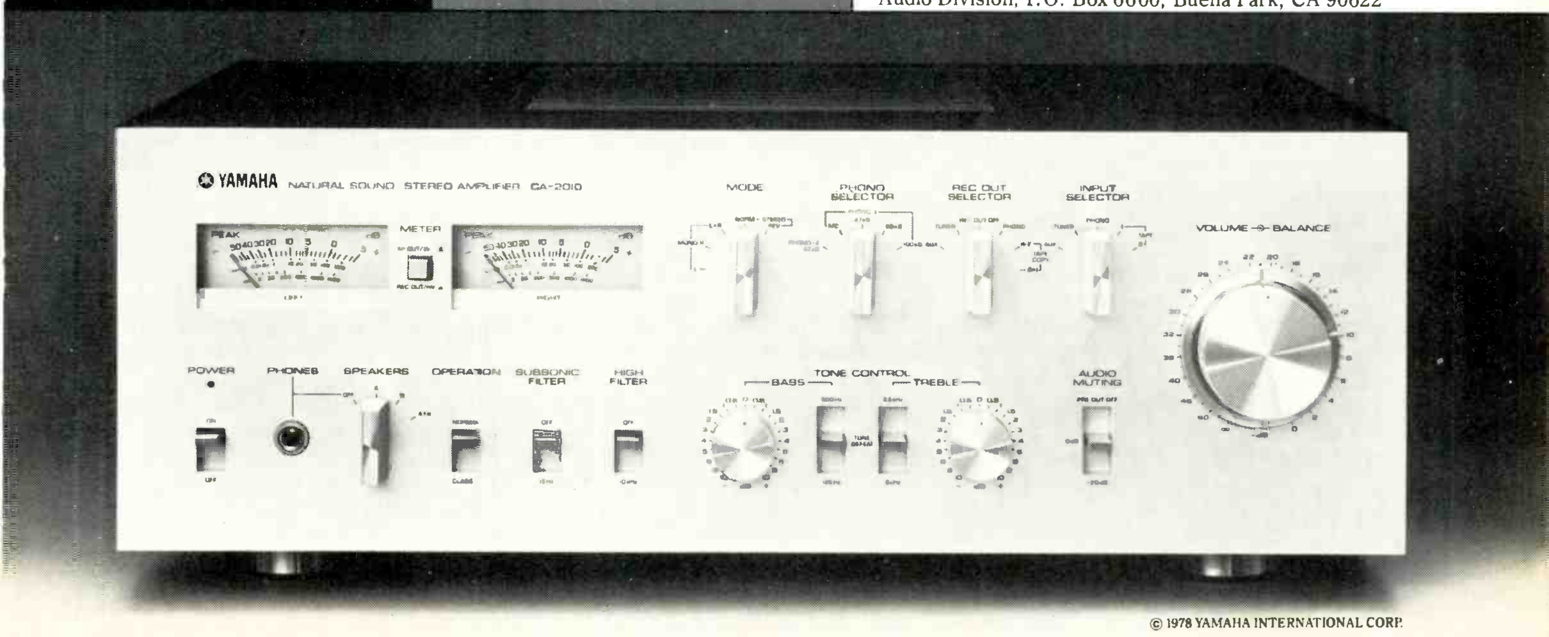

Bert Whyte

Behind the scenes

Since this column is concerned with room acoustics, their effect on sound reproduction, and possible modification of the listening room, it is understandably directed to those who have absolute control of their listening environment. (My utmost sympathies to the rest of you out there, who share your domain with someone who is not enamoured of stereo sound systems, who doesn't like the effect those large speaker enclosures have on the living room decor, and who definitely does not like loud listening levels.)

Let's assume that you have gone through a number of hi-fi systems and have progressed to the point where you now own a very sophisticated system. You're conversant with slew rates and SID and TIM and all that new-

fangled stuff, and like all dedicated audiophiles, you zealously pursue all manner and means of updating the quality of your system. In essence, you have become a "purist," and any signal-processing device that would sully the quality of your audio signal is an anathema to you.

Yet the moment you placed your loudspeakers in your listening room, no matter if they were the finest, most expensive units on the market, you created gross distortions of a magnitude far beyond what any processing device would impose on your audio signal. Depending on where you placed the speakers in the room, you would have varying degrees of time-delayed reflections, diffractions, and standing waves which cause ringing modes and all manner of peaks and dips, along with assorted acoustic anomalies. That lovely flat anechoic response of your speaker is now a shambles in the real-life situation of your listening room. What's that? You don't believe me?

If you were to perform an acoustic analysis of your listening room with such instruments as the UREI Sonipulse, the Shure M615AS, or the new Crown real-time analyzer, you would be shocked to find that you had a pretty ragged curve across the frequency spectrum. You may well find that you had a rising bass characteristic from 125 Hz down, with 63 Hz up +3 dB, 50 Hz perhaps up +6 dB, and 31 Hz up as much as 3 or 4 dB. All this is a major contribution to "boomy" bass response. You might be even more shocked with your high-end response, with progressive attenuation beyond 8 kHz, to the point where 12.5 kHz is down by 8 dB, and 15 kHz might be down as much as 11 or 12 dB (don't get panicky . . . a roll-off starting around 8 kHz is a natural consequence of absorption, diffusion, and progressive high-frequency attenuation with distance). Needless to say, these acoustic curves are considerably influenced by the character of the room . . . whether it has an average mix of reflective and absorptive elements, carpeting, furniture, etc. or is highly absorptive with much drapery, carpeting, and overstuffed furniture . . . or is very reflective with a lot of glass area, wood paneling, vinyl or tile floor, and sparse modern furniture upholstered with leather or vinyl. However, assuming an average room, analysis will reveal standing waves which, below 2 kHz, gives rise to audible ringing modes. At higher frequencies the standing waves become so complex and "cluttered" that they have a decreasing effect on sound reproduction. You may not consciously be aware of it, but these modes usually add a reverberant quality to the listening room. Obviously you would like to flatten the acoustic curve in your listening room, and while observing some technical constraints, there are a number of ways this can be accomplished.

Acoustic Analysis

Before remedial measures can be undertaken, the room must be acoustically analyzed, and fortunately for those who do not have access to the aforementioned instruments, there is an inexpensive but excellent alternative. This is the Crown Equalization Test Record, available through Crown dealers as part of the Crown EQ-2 Synergistic Equalizer system, and the dealer is also supposed to have high-quality SPL (sound pressure level) meters for rent. By buying the record, renting the meter, and buying a pad of special graph paper, ruled with a range from 20 Hz to 20 kHz, with standard ISO ⅓-octave centers in between, you're in business. The test record has 1-kHz reference levels for right and left channels. In the position in which you normally listen to your system, the SPL meter is referenced to 80 dB. The record then gives a voice announcement, followed by 10 seconds of pink noise of each of the ⅓-octave bands between 20 Hz to 20 kHz, and the graph is marked with the readings obtained from the SPL meter. Done with care, this gives quite an accurate acoustic response curve for your room. There is an extra added advantage in using this method, inasmuch as it incorporates the phono cartridge, RIAA circuitry, etc. in the overall response. There are, of course, a number of excellent pink-noise generators available from the likes of Ivie, UREI, and one is built into the Shure analyzer. These must be used with calibrated mikes and do not reflect the phono data.

Needless to say, the Crown people, Soundcraftsmen, Shure, etc., all make equalizers, and all the aforementioned analysis is to convince you of the need to buy one. Gadzooks! You can hear the purists screaming a mile away! None of this kind of circuitry for them, say they, mumbling about distortions and phase anomalies, etc. All right . . . leaving that subject for the moment, what can be done to correct the acoustic deficiencies in the room?

Damping with Fiberglas

The answer is that a new type of *fiberglas* comes to the rescue . . . *Fiberglas 703* is a semi-rigid material, supplied in 2 by 5-foot sheets in 1-, 2-, and 3-inch thicknesses. It is characterized by an almost 91 per cent absorption coefficient from 125 Hz to beyond 4 kHz. The 703 can successfully cope with most of the ringing modes in the room and deaden the room considerably. Of course, for the home listening room, we don't want it

to be "anechoically" dead, so ideally, the 703 should be applied in certain measure, and then the room is reanalyzed, and the final amount determined by results. How do you apply it? Here is where "saying what goes" comes into play. The 703 is the usual unattractive yellowish color, and, of course, you have the abrading of the glass fibers to contend with, which can cause physical discomfort such as itching. The problem can be solved by using a light Monks cloth cemented to the rear of the 703 batt without any loss of absorption. Insulation contractors will have special "spikes" . . . which have a square self-adhesive base and metal spikes of varying length; the spikes are set at intervals on the wall, and the batts of 703 are impaled on the spikes. Be warned . . . if you remove the spikes from painted or papered walls, they will usually remove some of the wall covering. Three-quarter-inch furring strips can also be used to mount the 703, with the plus here of some dead air space behind the batt, which helps absorption. The 703 batts can be fairly easily cut to various sizes and shapes for appropriate placing on the walls.

Where do you put the 703? Every room will be different, of course, but generally on a long wall in a rectangular room, with the opposite wall uncovered, unless the modes and reverberation in the room are quite pronounced. It is usually placed on the wall opposite your speakers, and if you are using a permanent quadraphonic speaker setup, then place it on the facing wall as well. The two-inch thickness is most practical to work with, and as to cost, 10 of the 4 by 5-foot batts are about $36.00. The 703 does a good job at a reasonable price.

There is another material, much fancier than the 703, and this is called *Soundfoam*. It is a polyurethane material which comes in 2 by 4-foot panels with self-adhesive backing, and thicknesses up to 1 inch. It is also available in an embossed pattern and in various colors. A special version comes with a layer of lead sandwiched between the foam, which affords a barrier against sound *transmission*, as well as its absorptive properties. Just the thing to cut down noise between apartments, although bass frequencies will still be transmitted through the floor and the adjacent studs. The Soundfoam is roughly 75 per cent as efficient as the 703, and it costs quite a bit more, but it is an attractive looking material and that may weigh heavily with many people.

Owens-Corning Fiberglas 703 can be obtained from most insulation contractors. The Soundfoam is obtainable from Soundcoat Co., 175 Pearl St., Brooklyn, NY 11201, who also make foam wedges for use in the construction of anechoic chambers.

Okay, so we have conquered a good part of the room acoustic problems, but what about the rising bass end and the treble roll-off? The answer has to be an equalizer . . . there is just no other way, except elaborate polycylindrical and free-form plywood diffusers and even these are not always the answer. Equalizers are like any other piece of audio equipment . . . you usually get what you pay for. In the graphic types there are the Crown, Klark-Technik, and Soundcraftsmen, and in the parametric type there are units from Technics, Orban, and SAE. All of them and others will correct the bass end. As for the treble, it really should be left in its naturally attenuated state, but if you insist in trying to restore some of the top end, do it quite moderately, remembering that a totally flat top will sound very hard and overbright. *A*

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No matter what system you own, a new Empire phono cartridge is certain to improve its performance.

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One, your records will last longer. Unlike other magnetic cartridges, Empire's moving iron design allows our diamond stylus to float free of its magnets and coils. This imposes much less weight on the record surface and insures longer record life.

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Three, Empire uses 4 poles, 4 coils, and 3 magnets (more than any other cartridge) for better balance and hum rejection.

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MODEL	4000 D/III	4000 D/I	2000Z	2000T	2000 E/III	2000 E/II	2000 E/I	2000 E	2000
FREQUENCY RESPONSE	10Hz-50kHz ± 3 dB	15Hz-45kHz ± 3 dB	20Hz-20kHz ± 2 dB	20Hz-20kHz + 1½ dB	20Hz-20kHz + 2 dB	20Hz-20kHz ± 2 dB	20Hz-20kHz ± 3 dB	20Hz-20kHz ± 3 dB	20Hz-20kHz ± 3 dB
TRACKING FORCE RANGE	¼-1¼ gm	1-1¾ gm	¾-1¼ gm	¾-1¼ gm	¾-1½ gm	¾-1½ gm	1-2 gm	1¼-2½ gm	1½-3 gm
SEPARATION 15Hz to 1kHz	28 dB	24 dB							
1kHz to 20kHz	23 dB	20 dB							
20kHz to 50kHz	15 dB	15 dB							
20Hz to 500Hz			20 dB	18 dB	20 dB	20 dB	18 dB	18 dB	16 dB
500Hz to 15kHz			30 dB	27 dB	28 dB	25 dB	23 dB	23 dB	21 dB
15kHz to 20 kHz			25 dB	22 dB	20 dB	18 dB	15 dB	15 dB	13 dB
I.M. DISTORTION @ 3.54 cm/sec	.2% 2kHz-20kHz	.2% 2kHz-20kHz	.08% 2kHz-20kHz	.08% 2kHz-20kHz	.1% 2kHz-20kHz	.15% 2kHz-20kHz	.2% 2kHz-20kHz	.2% 2kHz-20kHz	.2% 2kHz-20kHz
STYLUS	.2 mil bi-radial	.2 mil bi-radial	.2 x .7 mil elliptical	.2 x .7 mil elliptical	.2 x .7 mil elliptical	.2 x .7 mil elliptical	.2 x .7 mil elliptical	.3 x .7 mil elliptical	.7 mil spherical
EFFECTIVE TIP MASS	.4 milligram	.4 milligram	.2 milligram	.2 milligram	.6 milligram	.6 milligram	.6 milligram	.9 milligram	1 milligram
COMPLIANCE	30×10^{-6} cm/dyne	30×10^{-6} cm/dyne	30×10^{-6} cm/dyne	30×10^{-6} cm/dyne	20×10^{-6} cm/dyne	18×10^{-6} cm/dyne	17×10^{-6} cm/dyne	16×10^{-6} cm/dyne	14×10^{-6} cm/dyne
TRACKING ABILITY	32 cm/sec @ 1kHz @ 1 gm	30 cm/sec @ 1kHz @ 1½ gm	35 cm/sec @ 1kHz @ .9 gm	38 cm/sec @ 1kHz @ 1 gm	32 cm/sec @ 1kHz @ 1 gm	28 cm/sec @ 1kHz @ 1¼ gm	28 cm/sec @ 1kHz @ 1½ gm	28 cm/sec @ 1kHz @ 1¾ gm	32 cm/sec @ 1kHz @ 2 gm
CHANNEL BALANCE	within 1 dB @ 1kHz	within 1½ dB @ 1kHz	within ¾ dB @ 1kHz	within 1 dB @ 1kHz	within 1 dB @ 1kHz	within 1¼ dB @ 1kHz	within 1½ dB @ 1kHz	within 1½ dB @ 1kHz	within 1½ dB @ 1kHz
INPUT LOAD	100k Ohms/channel	100k Ohms/channel	47k Ohms/channel	47k Ohms/channel	47k Ohms/channel	47k Ohms/channel	47k Ohms/channel	47k Ohms/channel	47k Ohms/channel
TOTAL CAPACITANCE	under 100 pF/channel	under 100 pF/channel	300 pF/channel	300 pF/channel	400-500 pF/channel	400-500 pF/channel	400-500 pF/channel	400-500 pF/channel	400-500 pF/channel
OUTPUT @ 3.54 cm/sec	3 mV/channel	3 mV/channel	3 mV/channel	3 mV/channel	4.5 mV/channel	4.5 mV/channel	7 mV/channel	7 mV/channel	7 mV/channel

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Tape guide

Herman Burstein

Speed Measurement

Q. I have a tape recorder with an adjustable capstan motor capable of exact speed, but the problem is how to measure it.—Ed McElroy, Brookline, Mass.

A. Dubbings Electronics Co., 1305 S. Strong Ave., Copiague, N.Y. 11726 used to make stroboscopic wheels for measuring tape speed. You might write to them and find out if this device is still available. Some test tapes have timing signals included in them for measuring speed accuracy, so you might inquire about these at your local audio dealer.

Also you might construct your own measuring device by very carefully measuring a given length of tape, say 750 inches, and then measuring how long it takes the machine to run through this prescribed length. According to whether your machine runs through the tape in the exact time, fast, or slow, you can figure its accuracy. For example, the 750-in. tape should take 100 seconds at 7½ ips, but if the tape runs through in 95 seconds, then the speed is a little over 5 per cent fast; while if it runs through in 105 seconds, then it is a little over 5 per cent slow.

Performance Contradiction

Q. After much reading about tape recorder performance a basic contradiction in the available literature has become apparent. The conflict is one of "controlled bandwidth" vs. "extended response." Many recorders have flat response to 15 kHz at 3¾ ips, yet some manufacturers claim that about 12 kHz is the maximum usable response at 3¾ ips. Can you resolve this apparent contradiction?—Craig Chambers, Scott AFB,

A. Tape recorder performance involves juggling three basic factors, low distortion, extended treble response, and low noise. To maximize any one of these performance aspects requires sacrifices in one or both of the remaining aspects. Furthermore, there is the factor of time which can cause deterioration of the signal on tape with respect to both noise (specifically, print-through) and treble response. Taking all these factors into account, some of those who have studied the situation carefully have come to the conclusion that in the current state of the art, a reasonably conservative statement is that at 3¾ ips optimum performance should not seek flat treble response beyond about 13 or 14 kHz—about the limit of hearing for most adults.

One may get out to 15 kHz or higher at 3¾ ips, but this may not represent the *optimum* combination of low noise, low distortion, and wide treble response. And, it does not mean that the very highest frequencies recorded on the tape will retain their full magnitude some months from now. On the other hand, there has been constant progress in tape formulations so that we find the limits of treble response, without appreciable sacrifice in terms of noise and distortion, are steadily being expanded.

Deck Switching

Q. I would like to purchase a switching mechanism that would allow me to use either of two tape decks while leaving the monitoring function intact and permit dubbing from one tape recorder to the other. Can you advise me if such a unit is available and from whom?—Emil Aftandilian, Marion, Ill.

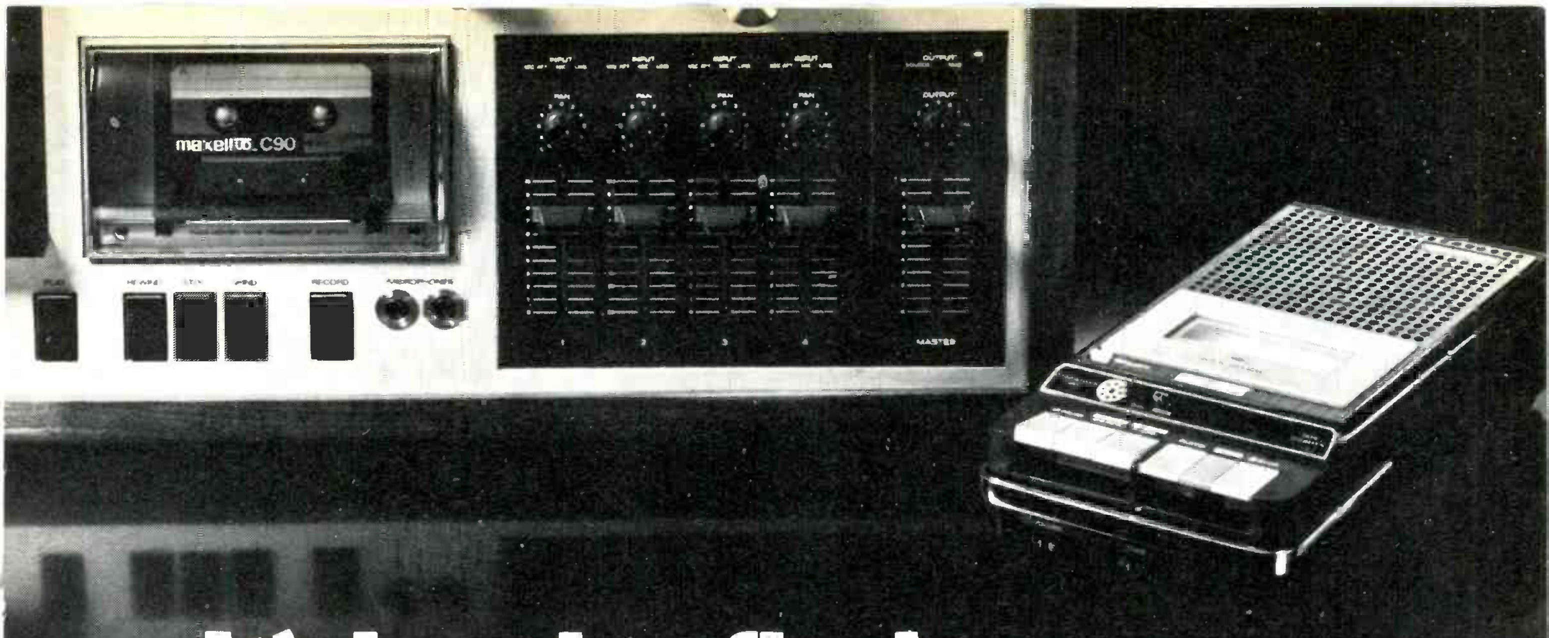
A. Inquire at Russound/FMP, Inc., P.O. Box 204, Stratham, N.H. 03885.

Tape Whistle

Q. When recording off FM I have noticed a very weak high-pitched whistle which is audible at 1⅞ and 3¾ ips, but not at 7½ ips. It sounds like some kind of feedback for if I lower the recording level it disappears.—Stan Schwartz, Storrs, Conn.

A. Most likely the whistle is due to overloading the tape which results in severe harmonic distortion, with the whistle being one of the harmonic products. At 7½ ips you are less likely to obtain such distortion because of less treble emphasis in recording.

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



It's hard to find a $1,000 tape deck that doesn't use Maxell. Or a $100 tape deck that shouldn't.

If you spent $1000 on a tape deck, you'd be concerned with hearing every bit of sound it could produce.

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Dear editor

Urban Tuner Update

Dear Sir:

In response to your article on "FM Specifications Revisited" (*Audio*, April, 1978) I think the most important parameters for an FM tuner in an urban environment are front-end dynamic range and adjacent-channel selectivity. Unless these design parameters are considered seriously by the design engineer, the tuner will not be able to receive many of the signals present at its antenna terminals.

I would change the list on page 62 as follows: 1) adjacent-channel selectivity, 2) alternate-channel selectivity, 3) spurious response and image rejection, 4) IM distortion and capture ratio, 5) 50-dB quieting, 6) usable sensitivity, 7) S/N@ 65 dBf, 8) THD @ 65 dBf, 9) frequency response, 10) i.f. rejection, 11) AM suppression and capture ratio, 12) SCA rejection, 13) stereo separation, and 14) subcarrier rejection.

The above list represent my basic thoughts when I designed the MR-78 tuner for McIntosh almost 10 years ago. The validity of the above list can be still shown today when one operates an MR-78 in the city of Hartford, Conn., in which location the MR-78 will pull in clear stereo signals from New York City's three classical music stations (WQXR, WNYC, and WNCN). There are no other tuners on the market that will do this. New York City is either completely inaudible or, at best, just discernible in the splatter from the strong Hartford local signals.

Just consider that the first job of an FM tuner is to pull in stations, then all else follows.

Richard Modaferri
Vestal, N.Y.

Horrendous AM

Dear Sir:

Today most AM/FM tuners above $350.00 have an FM section whose performance is quite comparable with other tuners in the same price range. However, the AM sections of these tuners possess a horrendous array of obscene distortions. This need not be the case, as the McKay-Dymek AM-5 tuner and DA-5 antenna have demonstrated with their high fidelity performance on an AM receiver. With the imminent FCC approval of stereo AM, manufacturers have a splendid chance to introduce high fidelity AM sections.

Through completely critical reviews of the AM sections of various tuners, *Audio* Magazine may help this along and, also, help the reader to purchase the best AM and best FM performance at a given price level.

Donald Kerr
Turtle Creek, Pa.

Engineering Empathy

Dear Sir:

With an electronic engineering background, I subscribe to *Audio* Magazine because of the technical emphasis of your publication. I do not subscribe to any of the so-called "underground" magazines because, while I agree that technical measurements do not necessarily predict how a product will sound, I do feel that the measurement process should not be abandoned, it needs to be refined. More research is required to correlate perceived sound quality with technical specifications. In this regard, the series of articles by Richard C. Heyser in *Audio* is excellent and I applaud his efforts.

As it is with most audiophiles, I suppose, I have an insatiable appetite for the "Equipment Profiles" and would like to see more contributions from Richard C. Heyser, Bascom King, George Pontis, et al. Leonard Feldman's reviews are adequate, although I wish he would place more emphasis on the listening evaluation. I very much appreciate the inclusion of schematic diagrams in the "Equipment Profiles" as I have a personal interest in correlations between the circuit topology and the perceived sound quality.

I also enjoy the construction articles presented in *Audio* and find their number well balanced with the technical articles.

Despite the claims of "noncommercial" audio magazines I, perhaps, naively believe that a "commercial" publication such as *Audio* can present an unbiased reflection of the state of the audio art. And with this reflection, I remain a committed subscriber.

D. Gary Lerude
Fairborn, O.

The Dahlquist DQ-10. Time...and Time again.

Critics and audiophiles agree — the listening quality of the DQ-10 is unexcelled. What accounts for its superb performance?

Time
Much credit for its smooth coherence must be given to the precisely matched transient characteristics of the five drivers. And, a good deal has been written about the DQ-10 and its extraordinary solution to the problems of time delay or phase distortion. It is not surprising that other high quality speaker designers have followed suit in offering their versions of time delay correction.

...and Time Again
The real "secret" to the unprecedented performance of the DQ-10 lies in Jon Dahlquist's patented method for reducing *diffraction*, a more audible and destructive form of *time* distortion. The separate baffle plate on which each driver is mounted is dimensioned to minimize diffraction in the frequency band in which it operates. Thus, the effect of the sound we hear is that of a driver mounted in free space, without obstructions or surfaces to distort the original sound source.

It can be said that the DQ-10 eliminates inaccurate reproduction caused by time elements — inertial time delay, and diffraction time delay — distortions that limit the performance of conventional speaker systems.

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New IHF Amp Standard

Edward J. Foster

As I write this article, the new IHF amplifier standard, designated "Standard Methods of Measurement for Audio Amplifiers, IHF-A-202, 1978," is being distributed to the Institute's membership for ratification. As you read this story, the standard will (I hope) have been approved and will be official.

A technical standard can easily be in committee for three years—longer is not unknown—and it has a truly useful life of perhaps three to five years—less is not unknown. Not that a standard will be replaced every few years—producing one is too formidable for such luxury—but technology changes so quickly that, within a short period, new "distortions" are "discovered" and new methods and specifications begin to appear. The uniformity of measurement and specification method, the *raison d'etre* of a standard, fades, and the clarity of comparison is obscured.

The IHF's previous amplifier standard was promulgated in 1966; the new one will be dated 1978. In that 12-year period, the audio industry grew from adolescence to relative maturity. The engineering fraternity drifted from the 1966 standard, and many incomparable specifications appeared. The IHF's Standards Committee set up a sub-committee to develop a more modern document, and once the FTC's 1974 "power ruling" became law, it was legally impossible to follow the letter of the 1966 document.

The amplifier standards committee first met in February, 1975, called together by Len Feldman, the IHF's Technical Director and head of all the standards committees. Almost three years later, a draft was approved by the IHF Executive Board and distributed to the membership for ratification. Over most of the period, I was associated with the subcommittee work—for half the time as Chairman.

Our initial hopes that the 1966 document could be revised and edited to bring it into step with the present soon were dashed, and, after struggling for a while with the extant standard, we decided that it would be better to strike out anew. That is what we did, using the 1966 document as a guideline to help to avoid missing something.

Definitions—Total Harmonic Distortion

To assure that everyone will be "talking the same lingo," an extensive section of definitions was first drafted to serve as the bedrock on which the standard rests. I'll take this opportunity to encourage anyone using the standard to study the definitions carefully as some are surprising. For example, total harmonic distortion is now defined in terms of the square root of the sum of the squares of the individual harmonic components, not as the reading of a conventional distortion analyzer, which also includes residual noise as part of "distortion." Now this is defined separately as THD + N, i.e. total harmonic distortion plus noise.

This is an example of the subtle differences in specifications that a redefinition can make. It is not necessary that every branch of electronics subscribe to our definitions; it is necessary that common definitions be used *within* the audio industry.

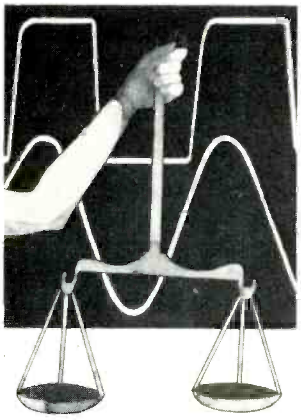
Why change the definition of THD? Mainly because the old definition was a misnomer including, as it did, the contribution of noise as part of distortion. You have seen curves taken on many amplifiers that indicate a greater "distortion" at reduced power levels than at more advanced power levels. In

It is generally agreed that higher order harmonics are more disturbing than those of lower order. The standard also provides for the possibility of a "weighted" total harmonic distorition measurement. . . .

the past, no one could tell whether this increase in "distortion" was due to a notch at the crossover (important) or to residual noise (not important insofar as the noise level is specified separately). By eliminating noise from the THD spec, the ambiguity is removed. And now that spectrum analyzers are available that can distinguish between individual distortion components, the new definition is practical as well as correct.

The widespread use of the spectrum analyzer has made it possible to determine other useful distortion parameters. The new standard provides for the specification of individual harmonic percentages, i.e. the percentage of second harmonic distortion, etc. It is generally agreed that harmonics of higher order are more disturbing than are those of lower order. The standard also provides for the possibility of a "weighted" total harmonic distortion measurement (W THD) to take this audibility factor into account. However, we don't yet know enough about the audibility of the various harmonics to standardize a weighting algorithm. Thus, the standard allows any algorithm to be used *provided* that it be made part of the spec.

Providing for the Future



Provisions for future measurements, even if they cannot be standardized now, permeate the 1978 document, as the committee attempted to anticipate future needs and provide sections within the standard that will form the basis of future measurements. It is our hope that IHF-A-202 will be a living document that will allow easier revision. In this way, we hope to keep it current with new technology and to increase its useful life.

In this vein, a definition of transient intermodulation distortion (TIM) is included, although no one method of measurement is specified. Several quasi-standard techniques for determining TIM have been proposed. Each puts a handle on the same physical behavior (or misbehavior) but yields results that are numerically different. Which of the methods yields the most useful results? How does one interpret the figures produced? At present, these questions are not easily answered. At one point, the standard included a specific method for determining TIM. It was, I believe wisely, decided not to incarcerate it in cement. We'd merely cut off future research into this interesting subject.

Intermodulation Distortion

Still on the subject of distortion, two methods are specified for the determination of intermodulation: the old "low-frequency/high-frequency" method that the previous standard endorsed and a new "two-tone" method as well. To distinguish between them, the former is called SMPTE-IM after the Society of Motion Picture and Television Engineers which first standardized it; the second is called IHF-IM.

The SMPTE-IM method determines the degree to which a high-frequency tone is amplitude modulated by a low-frequency signal. The IHF standard specifies that the two frequencies shall be 60 Hz and 7000 Hz, the most commonly used (but not universal) pair for this type of measurement. SMPTE-IM is easily measured with conventional IM analyzers. It provides a convenient means of determining intermodulation as a function of output level. Its Achilles' Heel is that it does not investigate behavior as a function of *frequency,* hence the desirability of an alternate intermodulation measurement that will do so.

The IHF-IM method also uses two frequencies, but they are to be swept across the audio band at a constant difference in frequency, that is f_2-f_1 will remain the same as f_1 and f_2 both move up the spectrum. The standard specifies a difference frequency of 1 kHz and that the mean frequency shall be swept from 2500 Hz (the practical lower limit) to the upper rated band edge of the amplifier. All intermodulation products (up to the fifth order) that lie within the audio band (20 Hz to 20 kHz) will be measured and combined to determine the percentage of IHF-IM. Such a measurement establishes intermodulation as a function of frequency, and the measurement can be repeated at various power levels to yield a series of curves of IM vs. frequency with output level as a parameter.

The IHF-IM method is similar to the CCIR-IM method but takes into account more of the higher order products. The IHF-IM method can be extended into the supersonic region and yield information related to transient intermodulation distortion. Either a spectrum analyzer or swept filter can be used to measure IHF-IM.

Whichever way that the intermodulation distortion is measured, the power level to which it refers is defined in terms of the average power level of a sinusoid of equivalent peak-to-peak amplitude. Although this is not the true power level of the two-tone signal, the power scale so defined is compatible with that used in a THD vs. power measurement.

Rated and Reference Characteristics

One source of confusion that the definitions section of the new standard seeks to relieve is the difference between a rated characteristic and a reference characteristic. The easiest way to keep them straight is to associate a *rated* characteristic with a *specification.* Ratings are derived from measurements. They are the numbers that the manufacturer claims are representative of the product's performance. A rating is a single value of a characteristic such as power output, distortion, etc. The ratings may be based upon curves (which may also be shown), but they themselves are the single values that represent the "worst-case" conditions.

A *reference* characteristic specifies the operating conditions under which the rated characteristic is specified. For example, the input-signal level, the output-signal level, the gain setting, etc. are reference characteristics that specify the conditions under which, say, distortion is *rated.*

The committee had to make two exceptions to this general rule. The "rated bandwidth" means the frequency range over which the performance of an amplifier is rated in other respects, e.g. power output. And the "rated load" of a power amplifier denotes the load impedance into which the amplifier is designed to operate in order to achieve its other ratings. "Reference bandwidth" and "reference load" would have been better terminology, however, the FTC power-out-

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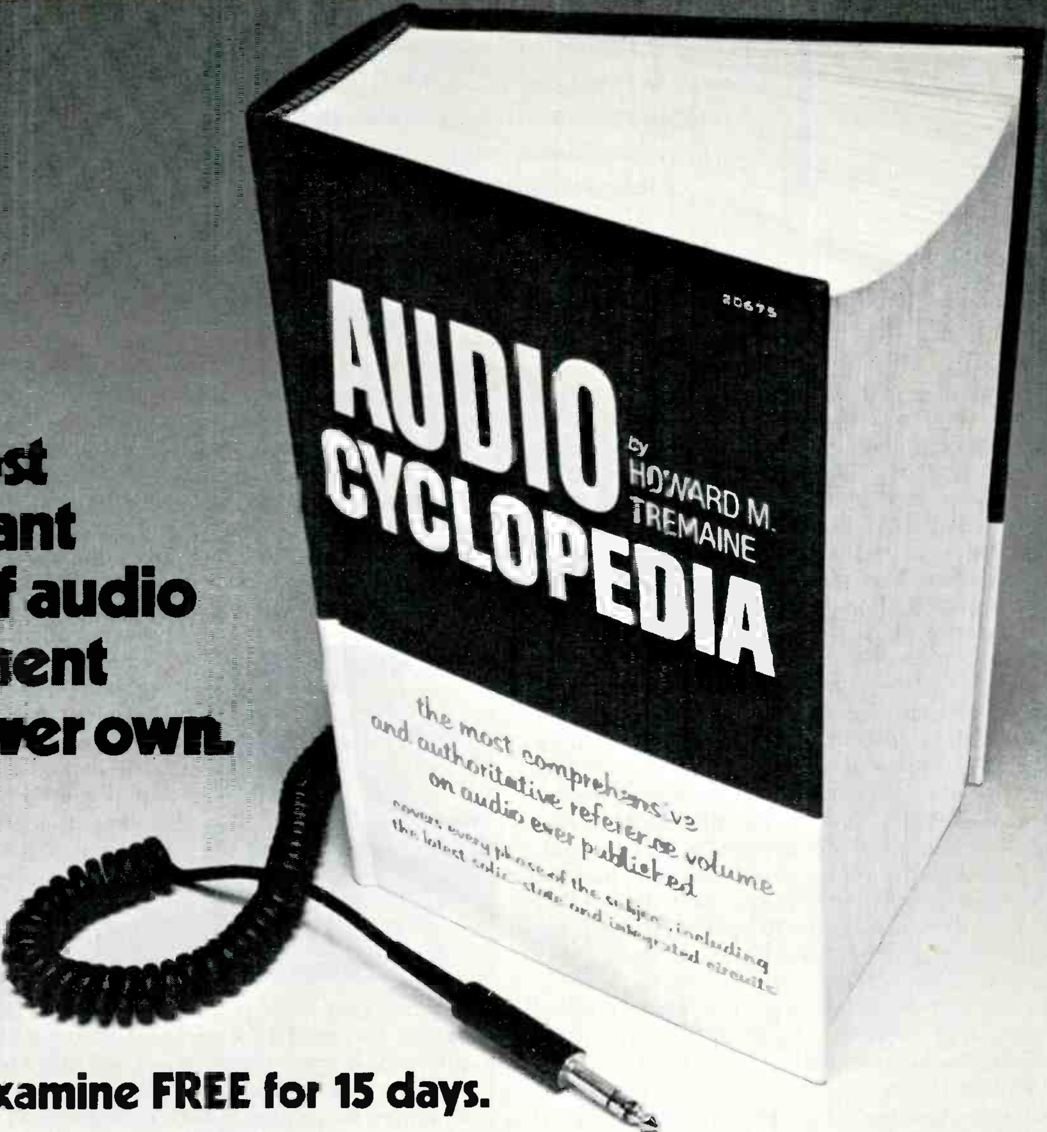

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Some committee members would have preferred to rate a power amplifier in terms of its voltage and current capabilities into a given load and avoid the "power" nomenclature entirely.

put ruling uses the terminology "rated" and, to comply with the letter of the law, we decided to conform to this unfortunate choice of words.

IHF References

In the past, manufacturers have used a variety of reference points. For example, the signal-to-noise ratio (S/N) of some amplifiers is referenced to the amplifier's rated output level, that is, a S/N of 80 dB meant that the *output*-noise power is 80 decibels below the maximum output level. Other amplifiers carried a rating referenced to a specific *input* voltage level. A S/N of 80 dB in this case means that the *equivalent input-noise* voltage is 80 decibels below the input reference level, say 10 mV for a phono input. Although both signal-to-noise ratios have the same numerical value, they are not comparable, and there is no convenient means of translating one into the other.

The usefulness of signal-to-noise ratio referenced to the amplifier's rated-output capability is further jeopardized by the fact that the actual noise power a given figure indicates depends upon the power-output rating. For example, consider two power amps, one rated at 10 watts, the other at 100 watts. Assume that each has an 80-dB S/N referred to its rated output. The 10-watt amplifier is actually 10 dB quieter than the more powerful amplifier because an output-noise power that is 80 dB below 10 watts is actually 90 dB below 100 watts, the difference between 10 watts and 100 watts being 10 dB.

It would appear that amplifiers whose noise level is referenced to a common input level can have their signal-to-noise ratios compared directly provided that the input reference level for the two measurements is the same. Unfortunately, even this isn't necessarily true. The noise level of some amplifiers is measured with the volume control fully advanced, others are measured with the volume control at a different setting. The resulting figures are incomparable, and there is no way to bring them into line.

Interdependent ratings that result from referencing one specification to another and ratings based upon non-standard test conditions result in specifications that cannot be compared. The consumer is faced with having to juggle numbers and with trying to translate each figure to a common reference point. Sometimes this can be achieved; sometimes it cannot.

One of the most important aspects of IHF-A-202 is its specification of standardized reference levels and standardized control settings. The underlying philosophy of the new standard is to rate an amplifier under conditions that simulate typical use.

Standard Test Conditions

The second section of the standard specifies the test conditions under which the amplifier is to be operated. Standardized input and output reference levels have been established. So have control settings. The input reference levels are 0.5 volt for a line input (AUX, Tape, Tuner, etc.), 5 millivolts (at 1 kHz) for moving-magnet or similar type phono cartridges, and 500 microvolts (also at 1 kHz) for moving-coil-cartridge inputs. These levels are typical of normal listening conditions. In practice, and on a dynamic basis, the input-signal level may be higher or lower depending upon the instantaneous level of the music.

The output reference levels are 1 watt for a power amplifier and 0.5 volt for a preamplifier—again, roughly the average operating conditions in the home. For the majority of the tests, all tone controls, filters, etc. are defeated (if possible) or they are set to their nominally flat positions. Gain controls are set so that an input of reference level produces an output of reference level.

These reference levels assure that each amplifier is tested under identical operating conditions, regardless of its maximum available gain or its power-output capability. An exception is made for an independent power amplifier. Many do not have a gain control, and it was thought best to test them all under conditions of maximum gain. Most power amplifiers have pretty much the same gain in any event.

Section 2 also standardizes a preamplifier output-load impedance—10,000 ohms in parallel with 1000 pF. The new preamp output-load impedance represents the approximate worst-case conditions when in use and is much lower in value than that specified in the 1966 standard. A power amplifier is tested with the manufacturer's "rated" load, but an IHF reference-load impedance is specified as 8 ohms nonetheless.

For the first time, standardized input termination impedances are specified—a resistor of 1000 ohms for each line and moving-magnet phono input and 100 ohms for moving-coil phono inputs. No longer will amplifiers be rated under zero source impedance (ideal) conditions. Finally, section 2 specifies the characteristics and the accuracy of the test equipment to be used.

Section 3—The Meat of the Standard

The third section details the tests that are to be performed on a single-channel amplifier. It also specifies how a rating is to be derived from the test results. Each subsection of 3.0 outlines the deviations from standard test conditions that are required for the test to be performed properly. By FTC dictate, the first and foremost spec for a power amplifier is the continuous average power output rating (sometimes mislabeled "RMS Power.")

Section 3.1 relates to this rating and is in compliance with the FTC ruling as currently interpreted. Enough has been written about this ruling to eliminate the need for repeating it here. The only deviation from the standard test conditions is in the setting of the gain control. For practical reasons, it is adjusted for an extra 12 dB of gain.

Two other points should be noted. For the purposes of the standard, power is defined in terms of a voltage measurement—as the square of the voltage divided by the load impedance. As long as the signal is sinusoidal, and the output and load impedance purely resistive, the figure so calculated is indeed the power in watts. When the impedances are partially or totally reactive, or when the signal being measured is not sinusoidal (for example, residual noise), the calculation from a voltage measurement (with the type of voltmeter specified in the standard) does not yield "true" power.

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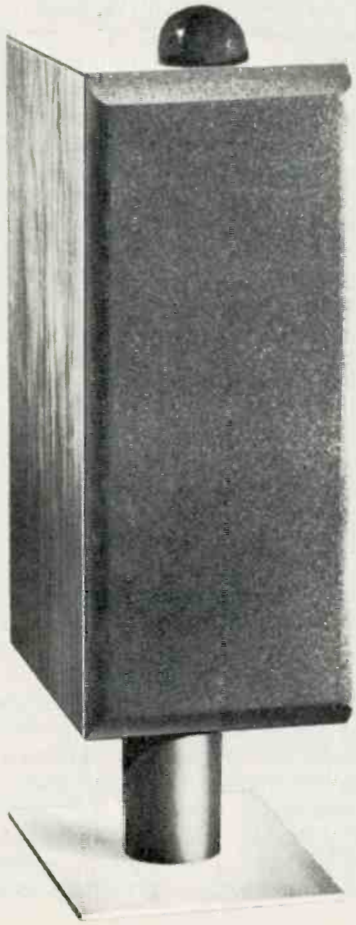

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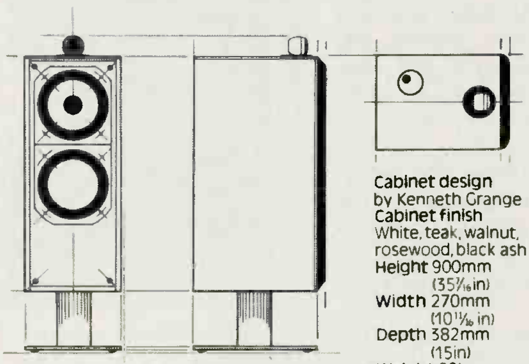

Cabinet design by Kenneth Grange
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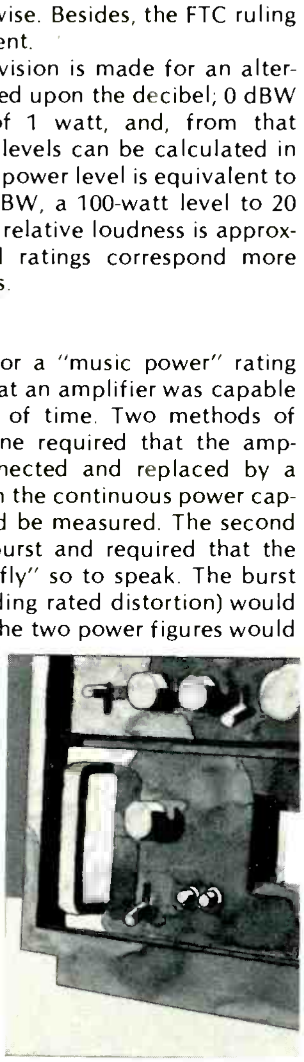
Since our sensation of relative loudness is approximately logarithmic, dBW-based ratings correspond more closely to how "loud" the sound is.

Nonetheless, we have defined it as such—the reason being that this is, in fact, the way measurements are made. By acknowledging this point in the definitions, we assure that everyone is talking the same language even if it is questionable theoretically. Some committee members (myself included) would have preferred to rate a power amplifier in terms of its voltage and current capabilities into a given load and to avoid the "power" nomenclature entirely. However, the consumer is so used to the concept of power that such a radical change was felt to be unwise. Besides, the FTC ruling is based upon a power measurement.

In the definitions section, provision is made for an alternate logarithmic power scale based upon the decibel; 0 dBW is defined as the equivalent of 1 watt, and, from that reference point, all other power levels can be calculated in the customary manner. A 10-watt power level is equivalent to 10 dBW, a 20-watt level to 13 dBW, a 100-watt level to 20 dBW, etc. Since our sensation of relative loudness is approximately logarithmic, dBW-based ratings correspond more closely to how "loud" the sound is.

Dynamic Headroom

The 1966 standard provided for a "music power" rating that indicated the power level that an amplifier was capable of supplying for a short period of time. Two methods of measurement were specified. One required that the amplifier's power supply be disconnected and replaced by a regulated laboratory supply. Then the continuous power capability (at rated distortion) would be measured. The second method used a modified tone burst and required that the distortion be measured "on the fly" so to speak. The burst power capability (without exceeding rated distortion) would then be measured. The lower of the two power figures would be the "music power rating."



The measurement fell into disuse for a variety of reasons. Measurement of small percentages of distortion on a dynamic basis is problematic at best, and replacing the amplifier's power supply with a laboratory supply is often not feasible. Furthermore, a few quasi-high-fidelity manufacturers took advantage of the technique to advertise a hyped "IHF" power in watts and ignored the continuous power altogether.

Nonetheless, the concept of measuring the power capability of an amplifier under pulsed conditions is a good one. Music is composed of series of transients. The average power content of a program is usually quite small, but, on occasion, large bursts of power are required. An amplifier that has the reserve capacity to provide this power will be capable of the same level of reproduction (on a given speaker) as an amplifier of greater continuous power capability but no greater reserve.

Thus, the committee felt it important to indicate the reserve capacity of an amplifier. We did not want to specify it in watts and risk the same two-power-rating confusion of the past. The solution that we came up with is called the dynamic headroom rating. This rating expresses the number of decibels by which the short-term power capability exceeds the continuous power rating. A dynamic headroom rating of 3 dB means that the amplifier can supply twice the power on a burst basis than it can provide continuously. A dynamic headroom of 0 dB indicates that the power supply is well regulated but that, as far as music is concerned, no greater power is available for peaks than for continuous sine waves.

The signal chosen to simulate music consists of a 1-kHz sinusoid that increases in level by 20 dB for a period of 20 milliseconds. The burst is repeated twice a second. Recent research indicates that few musical peaks exceed 20 milliseconds in duration and that they occur much less frequently than twice a second. The repetition rate was chosen for convenience of measurement and represents a somewhat more stringent requirement than music demands. Rather than attempt to measure distortion on a dynamic basis, the standard calls for the determination of the burst-power capability at the clipping point of the amplifier (by means of visual observation of the signal on an oscilloscope). Today's amplifiers enter the clipping region very abruptly, and the difference in power capability as measured at some arbitrary percentage of distortion and that at clipping is negligible. A similar measurement is specified for the clipping power headroom rating. The difference between the two is that clipping power headroom is measured with a continuous sinusoidal input rather than with the burst.

The maximum voltage output of a preamplifier, or, for that matter, any set of line-output terminals, is defined as the output voltage at which the THD reaches 1 per cent. Standard loading is used, of course, but, for practical considerations, the gain is increased by 12 dB over that specified by the standard test conditions. The 1 per cent-THD point probably corresponds to the onset of clipping, and the THD under normal operating conditions will be much less. For that reason, THD is specified separately at 2.0-volt output level, i.e. with a standard input level and 12-dB additional gain. There is no reason to measure preamps with a tone burst since it is most unusual for their maximum output capability to be any greater on a dynamic basis than on a continuous basis.

The maximum input signal level indicates the point at which the *input* circuitry overloads. The new standard specifies that the rating shall be the *minimum* input overload level anywhere within the rated bandwidth. The input level at which a phono preamp overloads varies with frequency because of the equalization curve employed. The new standard takes this into account by requiring that the maximum input signal rating be given on the basis of the *equivalent* 1-kHz overload point, after adjusting the measurements for the effect of the equalization.

Sensitivity and Signal-to-Noise Ratio

The sensitivity and S/N of an amplifier rated in accordance with the new standard are likely to be quite different from those published in the past. As indicated previously, the thrust of the new standard is to eliminate interdependency between ratings by referencing to standard output levels (0.5 volts and 1 watt). The new sensitivity rating is the input voltage level required to achieve the *reference output level* with the gain control set at its position of maximum gain. The

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GX-650D Reel Capacity: Up to 10½" reel; **Tape Speed:** 15, 7½ and 3¾ ips (± 0.5%); **Wow/Flutter:** Less than 0.04% RMS at 15 ips; **Frequency Response:** 30 Hz to 30,000 Hz (± 3 dB) at 15 ips; **Distortion:** Less than 0.4% at 15 and 7½ ips (1,000 Hz "O" VU); **Signal-to-Noise Ratio:** Better than 58 dB (measured via tape with peak recording level of +6 VU); **Heads:** (3) one GX Playback, one GX Recording and one Erase Head; **Motors:** (3) one AC Servo Motor for capstan drive; two Eddy Current Motors for reel drive.

GX-270D Reel Capacity: Up to 7" reel; **Tape Speed:** 7½ and 3¾ ips (± 0.7%); **Wow/Flutter:** Less than 0.06% RMS at 7½ ips; **Frequency Response:** 30 Hz to 23,000 Hz (± 3 dB) at 7½ ips; **Distortion:** Less than 1% (1,000 Hz "O" VU); **Signal-to-Noise Ratio:** Better than 60 dB (measured via tape with peak recording level of +6 VU); **Heads:** (3) one GX Forward Playback, one GX Reverse Playback, one combination GX Recording/Erase Head; **Motors:** (3) one AC Servo Motor for capstan drive, two Eddy Current Motors for reel drive.

4000DS Mk II Reel Capacity: Up to 7" reel; **Tape Speed:** 7½ and 3¾ ips (± 2%); **Wow/Flutter:** Less than 0.12% WRMS at 7½ ips; **Frequency Response:** 30 Hz to 23,000 Hz (± 3 dB) at 7½ ips; **Distortion:** Less than 1% (1,000 Hz "O" VU); **Signal-to-Noise Ratio:** Better than 56 dB (measured via tape with peak recording level of +6 VU); **Heads:** (3) One 1-micron gap Playback head, one Recording head, one Erase head; **Motor:** 4-pole induction motor.

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From the beginning, the name AKAI has been synonymous with some of the most significant discoveries in the audio recording field.

First, AKAI led the industry with the electronics and technology required to produce the very finest motors, the heart of a tape recorder. Another advancement was the exclusive AKAI glass and crystal ferrite (GX) head—it remains totally unsurpassed for optimum sound and wearability—guaranteed for 150,000 hours, the equivalent of playing 24 hours a day for 17½ years.

Today, AKAI continues to make one of the broadest lines of two and four channel reel-to-reel decks. And our 20+ years in the business go into every deck to keep them best-sellers. From the high performance GX-650D loaded with features, to the mid-priced GX-270D with reverse record and playback, to the hottest-selling 4000DS Mk II. For multi-track recording, the Quadra-Sync® GX-630DSS is also available.

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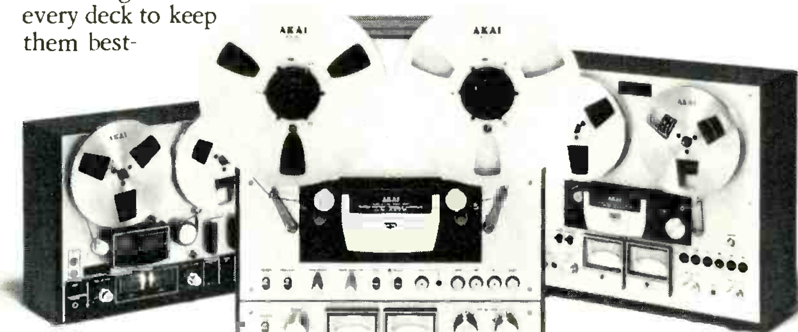

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The Dynamic Headroom rating expresses the number of decibels by which the short-term power capability exceeds the continuous power rating.

new sensitivity figures will appear to be much lower, i.e. the amplifier will appear to be more sensitive, than in the past since heretofore "sensitivity" denoted the input voltage required to reach *rated,* rather than *reference,* output. To determine the input voltage necessary to reach full or rated output, the consumer will have to multiply the new sensitivity figure by the factor with which the amplifier's rated output exceeds the reference output. In essence, the "new" sensitivity figures reveal the maximum gain of the amplifier, unconfused by its rated-output level. For that reason, we felt that the new approach will be beneficial in the long run.

Signal-to-noise ratios will also be numerically different for they too will be referred to a standard level rather than to the rated-output level. The importance of this was explained under the section "IHF References." Suffice it to say that the IHF signal-to-noise rating will be based upon an A-weighted noise measurement rather than an unweighted measurement. And, be it noted that weighting is *not* a subterfuge to make the numbers "look better." It is an honest attempt at making the numbers reflect the *audibility* of noise so that the amplifier with the better S/N ratio will indeed sound quieter in practice. After considering many different weighting curves, the "A" was chosen as being reasonably accurate and well established in the mind of the consumer. Provision is also made for weighting in accordance with the so-called CCIR/ARM method.

Furthermore, the S/N rating called for in the new standard is based upon a terminated rather than upon a shorted input. The terminations are as specified before except that moving-magnet phono inputs will be terminated with an R-L-C circuit that simulates the source impedance of fixed-coil cartridges.

Frequency Response and Filters

There are two major changes in frequency-response rating. The new ratings will indicate the response with the gain control set in accordance with the standard test conditions, not with it set for maximum gain as was customary. Thus, the rating will reflect the response under typical conditions of use rather than under artificial ones. For many amplifiers, there may be no difference at all. However, some amplifiers do not exhibit quite so good a high-frequency response with the volume turned down as they do with it at maximum. This is reflected in the new rating.

The second change is one of clarification. The frequency response will be given as the plus and minus decibel error in gain *referenced to a 1-kHz signal.* Thus, an amplifier that is flat through the midband and down 3 dB at 10 Hz and 100 kHz will be specified as +0 dB, −3 dB, 10 Hz to 100 kHz rather than as ±1½ dB over that range. Many manufacturers do this now; some do not. Clarification was in order. The frequency response rating of an equalized phono preamp will be the plus and minus decibel error *in equalization* referenced to 1 kHz.

The cutoff frequency rating of a filter is now clearly specified as that frequency at which the gain is reduced by 3 dB. The slope rating is the asymptotic limit of the response vs. frequency curve in dB octave.

Input and Output Impedance and Damping Factor

Most high-fidelity amplifiers are not designed to operate under "matched-impedance" conditions. As long as the input impedance of a subsequent device is much greater than the output impedance of the preceeding equipment, the two will normally be compatible in this regard. The major exception to this generalization regards phono-input circuitry—especially that designed to work with fixed-coil cartridges. The majority of these phono cartridges are designed for optimum performance into a specific load. The typical load is that presented by a 47-kilohm resistor in parallel with a specific value of capacitance, typically between 200 pF and 450 pF.

The new standard acknowledges the importance of proper phono-cartridge matching by requiring that the input impedance be measured at a variety of frequencies. *If* the input impedance can be accurately modeled by a parallel combination of resistance and capacitance, then the R and C values will be given as the input impedance rating.

If, as sometimes happens, the input impedance is too complex to be modeled with a parallel R-C combination, then the magnitude of the impedance at 1 kHz (in ohms) will be given as the rating. The astute consumer should look for a resistor-capacitor-type rating of *phono-input impedance,* for this indicates a "classic" input circuit that will provide the proper termination for a cartridge (assuming, of course, that the resistor and capacitor values are appropriate or can be made to be appropriate for the cartridge in use).

The output impedance of an amplifier will now be measured with a standardized signal-current flow through the load. The current specified approximates that in typical operation. The damping factor of a power amplifier is, of course, related to its output impedance and, by definition in the new standard, is 8 ohms divided by the output impedance.

Provision is made for two damping factor ratings. The wideband damping factor rating is the *minimum* damping factor over the rated bandwidth of the amplifier. The low-frequency damping factor is that measured at a frequency of 50 Hz—the typical resonant point of dynamic loudspeakers. (Past practice called for the damping factor to be measured at 1 kHz.)

Transient Specifications

The majority of an amplifier's ratings are based upon measurements taken under steady-state, sinusoidal-signal conditions. (The one exception that was already mentioned is the dynamic headroom rating.) In real life, a high-fidelity amplifier seldom operates that way, music being basically transient in nature. Several new measurement methods have been incorporated into the standard to determine the transient performance of an amplifier.

On occasion, an amplifier may be driven into clipping by a high-level transient. How quickly it recovers can be important in establishing the sound quality. If the amplifier recovers instantaneously after a brief overload, its misbehavior is less apparent than if it introduces a low-frequency perturbation after the overload or if it "blocks" for some period of time.

The transient-overload recovery time rating is a measure of such behavior. The test signal simulates music and is the same as that used to determine dynamic headroom, i.e. a 1-kHz signal that, for 20 milliseconds out of every ½ second, increases in level by 20 dB. For the overload test, the input level is adjusted so that the amplifier is driven 10 dB into

the (w)hole story

For years, SAE has been producing "state-of-the-art" separate components that offer value, quality and performance. That experience has now been applied to a line of integrated amplifiers. But what's the hole for? The answer is, ultimate performance!

Unlike others, our integrateds are identical to our separates with the same designs and component parts already proven in SAE preamps and amps. But that's not all - in each of our integrateds the preamp and amp section is entirely separated (even the power supply!). The preamp section, which is identical to our 2900 (or 3000, depending on the model) has its inputs and outputs near the front (hence the need for the hole), while the amp section (2200 or 3100) is at the rear. The only common parts are the chassis and the power switch. This unusual "U" shape design provides isolation of low and high level circuits, while retaining easy access to inputs and outputs (now only 3.5" behind the front panel).

These new units are so unique we don't consider them integrateds. Instead, we call them preamp/amps. They meet all the goals of an ideal integrated; (1) Convenience of an integrated design; (2) Excellent value due to reduced packaging costs; 3) The performance of separate components.

No matter which of SAE's preamp/amps you choose - the 2922 with parametric EQ and 100 watts* per channel, 3022 with tone controls and 100 watts* per channel or the 3031 with tone controls and 50 watts* per channel, you are assured of SAE performance, quality and value. The preamp/amps are truly integrated separates. And that's the whole story.

*Per FTC Rating @ 8 ohms

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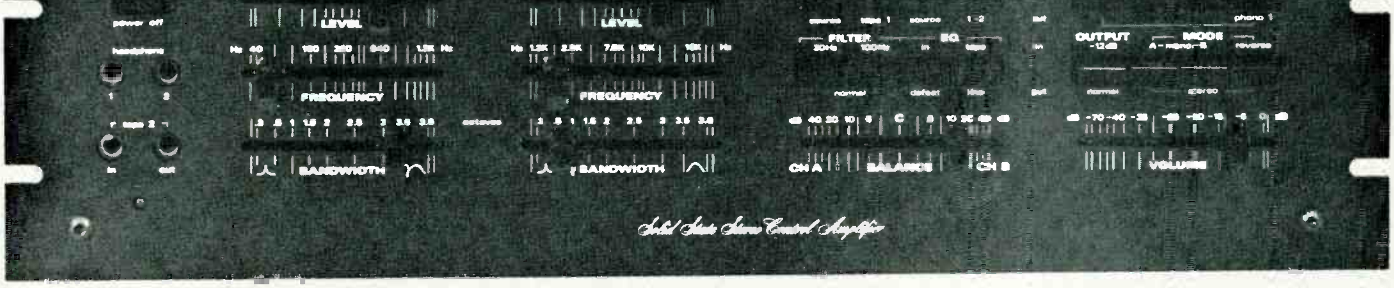

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The TC-K7 II front-loading cassette deck is its own best spokesman.

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And no wonder. Sony's been making tape recorders for 30 years. And today, we're still pushing back the frontiers. The K7 II shows how.

Its transport mechanism is a DC servo-controlled motor, with a frequency generator. It emits a signal which is relayed to electronic circuitry that locks in the tape movement exactly.

Our heads are ferrite-and-ferrite. And they're Sony's own formula—we don't buy them, we use our heads and make them.

You'll also find a direct-coupled head-playback amplifier. This means we've eliminated the middleman —the coupling capacitor—from the signal path. You get your sound direct, with minimum distortion.

Another reason the K7 II is the logical choice: our logic controlled feathertouch push-buttons actually go from fast-forward, to rewind, to play, without going through the stop position.

The K7 II also speaks for itself with Dolby Noise Reduction System.™ Large, professionally calibrated VU meters. Three LED's for peak level indication.

There's also bias and equalization switches for standard, Ferri-Chrome and Chromium Dioxide tapes. In fact, with nine possible combinations, any tape possibility of the future can be accommodated.

So if you're intrigued by quality that speaks for itself, get down to your Sony dealer and check this new cassette deck.

Before they're all spoken for.

Sony quality that doesn't speak at all.

But it won't be silent for long. Because the moment you record on one of our blank tapes, that quality will make itself heard.

Witness our Ferri-Chrome cassette.

Everybody knows that ferric-oxide tapes are ideal for reproducing the low frequencies. And that chromium dioxide is ideal for the high frequencies.

As usual, Sony wouldn't settle for anything but the best of both.

And as usual, Sony's engineers solved the problem. With a process that allows a coating of chromium dioxide to be applied over a coating of ferric-oxide.

Our two coats are leaving other brands of tape out in the cold. Because Ferri-Chrome boasts shockingly low distortion and startling dynamic range.

Sony is this advanced because we make more than tape. We make tape heads and tape recorders, too. (No other consumer company is that involved.) Because we know where tape winds up, we're better able to design and produce it.

Of course, in addition to Ferri-Chrome, Sony makes a complete line: Chrome, Hi-Fidelity, Low Noise, Elcaset and Microcassette.

Sony's been making tape for 30 years.

So when it comes to answering the tough questions about the manufacture of tape, no one fills in the blanks like Sony.

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To determine the voltage necessary to reach full or rated output, the consumer will have to multiply the new sensitivity figure by the factor with which the amplifier's rated output exceeds the reference output.

overload by the burst. The time taken by the amplifier to recover is measured and constitutes the rating.

Some manufacturers have been specifying the slew rate and rise time of their products. There are a variety of ways to make such measurements, and there is usually no assurance that the amplifier is behaving in a linear fashion as the measurement is being made. Furthermore, the data presented is interdependent with the amplifier's output rating in that a more powerful amplifier needs to slew faster than a less powerful amplifier in order to provide its full rated-output capability under dynamic conditions. After considering several possible methods of measurement, some of which appeared in intermediate drafts, the committee decided upon a new slew factor measurement which would yield the requisite information, under linear operating conditions, and be independent of the output rating of the device.

TABLE I — PRIMARY SPECIFICATIONS.

Power Amplifiers:	Continuous Average Power Output*
	Dynamic Headroom
	Frequency Response
	Sensitivity
	A-weighted S/N
Preamplifiers:	Frequency Response
	Maximum Voltage Output
	Total Harmonic Distortion
	Sensitivity
	A-weighted S/N
	Maximum Input Signal
	Input Impedance
Integrated Amplifiers:	Continuous Average Power Output*
	Dynamic Headroom
	Frequency Response
	Sensitivity
	A-weighted S/N
	Maximum Input Signal
	Input Impedance

*—The continuous average power output rating includes the rated bandwidth, the rated load impedance, and the total harmonic tortion.

The slew factor is actually a measure of the highest frequency that can be applied at the input terminals of an amplifier and be reproduced at the ouput with no greater than 1 per cent THD. That frequency, divided by 20 kHz, is defined as the slew *factor*. The input level is first adjusted to yield the rated output at a frequency of 1 kHz and is maintained at that level throughout the test.

An amplifier that incorporates an input low-pass filter to prevent TIM will have a very high slew factor, since the high-frequency THD may never exceed 1 per cent. The effect of such a filter would have been indicated in the frequency-response rating, and, properly, it should not appear in the slew factor rating as well. If the slew rate or rise time had been measured directly, the effect of such a filter would be to degrade the rating *even though the filter was designed into the amplifier specifically to avoid TIM problems.* Many observers correlate a low slew rate, or a slow rise time, with high TIM. But, this is not necessarily the case. It depends upon *what* is causing the lower slew rate or the slower rise time—a low-pass filter designed to *avoid* TIM or a basic limitation in high-frequency power capability. The difficulty of interpreting a slew-rate or rise-time spec was precisely what the committee intended to avoid in establishing the slew factor rating.

Real-Life Loads

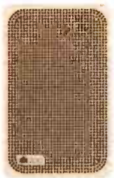
Power amplifiers are customarily measured with a purely resistive load, and the FTC ruling is based upon such measurements. Yet, typical loudspeakers present a partially reactive load to the amplifier. Since the current through a reactive load is not in phase with the voltage across it, the operating conditions experienced by the amplifier's output circuitry are quite different in real life from what they are on the test bench. With a real loudspeaker, the amplifier's output-protective circuitry may be triggered at a substantially lower power level than it would be with a resistive load. In such a case, the "practical" power-output capability is less than that given by the standard ratings.

The reactive-load rating indicates the relative power capability of the amplifier when driving a dynamic loudspeaker compared to the amp's capability when driving a resistive load. Most protective-circuitry problems crop up only in the low-frequency region about the speaker's primary resonance. The standard specifies a load that simulates the impedance of a loudspeaker in that region. This reactive load was synthesized to represent the average impedance characteristics of some 20 commercial loudspeakers. It has a resonant frequency of about 50 Hz, an impedance at resonance of approximately 24 ohms and worst-case phase angles of ±39 degrees at 40 Hz and 63 Hz.

TABLE II — SECONDARY DISCLOSURES.

Clipping Headroom	Filter Slope	Slew Factor
Output Impedance	Crosstalk	Reactive Load
Wideband Damping Factor	A-weighted Crosstalk	Capacitive Load
Low-Frequency Damping Factor	CCIR/ARM Crosstalk	Separation
CCIR/ARM Signal-to-Noise Ratio	SMPTE Intermodulation Distortion	Difference of Frequency Response
Tone-Control Response	IHF Intermodulation Distortion	Gain-Tracking Error
Filter Cutoff Frequency	Transient-Overload Recovery Time	Tone-Control Tracking Error

These Two Speakers Made ADS Famous.



Have you heard the others?

On the left is a little jewel, our ADS 200: the original miniature loudspeaker and the world's first to render true high fidelity in a precision package small enough to fit in the palm of your hand. All national and international reviews acclaimed the ADS 200 for unsurpassed musicality, clarity, and acoustic efficiency.

Our ADS 910, to the right, was designed to be a classical studio monitor combining maximum versatility with options such as internal bi-amplification, crossover response contouring, and power meters: state-of-the-art refinements which in our opinion should not be reserved exclusively for tonmeisters and recording engineers. If you personally put a premium on ultimate music reproduction, the ADS 910 provides the standard for years to come in the science/art of faithful monitoring at a fair price.

Once you understand that our mini ADS 200 and professional model 910 are both built to the same criteria – absolute neutrality and the proverbial ADS clarity – then the design philosophy for our entire line of ADS loudspeakers becomes evident: except for progressive maximum loudness and depth in the lowest bass, all ADS speakers sound the same. Or rather, they don't sound at all! This is the famous "Invisible Sound" of ADS – a flawless linearity and cleanness of sound that lets the speakers disappear, leaving only the music.

Which of our eight speaker sizes is right for you? Your choice will depend on several factors: the kind of music you like, how loudly you like to play it; the size and liveness of your room; and how much you can afford to spend. One factor will not influence your choice: you will hear no variation in the quality of sound from the smallest to the largest ADS speakers. No other line of speakers is so free of individual speaker personalities. STEREO REVIEW says of the medium size ADS 810, for example, "... one of the very few speakers we have tested in the past ten years or so that was so accurate that we could not distinguish its sound from the original in a side-by-side comparison."

Interested in finding out more about ADS loudspeakers? Send us the coupon below for informative data sheets and complete test reports. Better yet, conduct your own critical A/B comparison at a local selected ADS dealer. Hear the ADS 200 or the 910. Listen to the others. Then pick the model that is perfect for you.

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The maximum output-voltage capability of the amplifier (determined by the 1 per cent THD point) is measured at 40 Hz and 63 Hz. The maximum output "power" is computed from the lesser of the two voltages, and the ratio of that "power" to the rated power, in decibels, is the reactive-load rating.

A reactive-load rating of 0 dB means that the amplifier is capable of supplying its advertised "power" into a typical loudspeaker. A negative reactive-load rating indicates that the level available to a typical dynamic loudspeaker is less than the advertised figure by that number of decibels.

The capacitive-load rating is given in terms of the range of values of capacitance that can be connected to the output terminals, in parallel with the rated ouput-load impedance, without evidence of instability or any change of ratings in excess of 10 per cent.

Multi-Channel Amplifiers

Section 4 of the standard deals with multi-channel, i.e. stereo or quadraphonic, amplifiers. Essentially, it states that a multi-channel amplifier is rated in the same manner as is a single-channel amplifier, except that all channels are to be driven simultaneously when the measurements are made.

It also specifies a separation rating as the minimum value of channel separation, i.e. left-to-right signal leakage (in dB) at any frequency between 100 Hz and 10 kHz. Crosstalk between various inputs of the *same* channel, e.g. between the phono and tape inputs, etc., is measured and specified in a similar manner on a single-channel basis as outlined in section 3. A weighted-crosstalk measurement is also provided. It uses band-limited pink noise as the signal source, and the same weighting curve as is used for noise measurement. Note the difference between channel *separation* and *crosstalk* between inputs of the *same* channel.

Also included in the multi-channel-amplifier section are measurements of the difference in the frequency response of the various channels, the gain-tracking error, i.e. unbalance in the relative gain of the various channels as the volume control is changed, and a tone-control tracking error rating that accomplishes the same purpose for these controls.

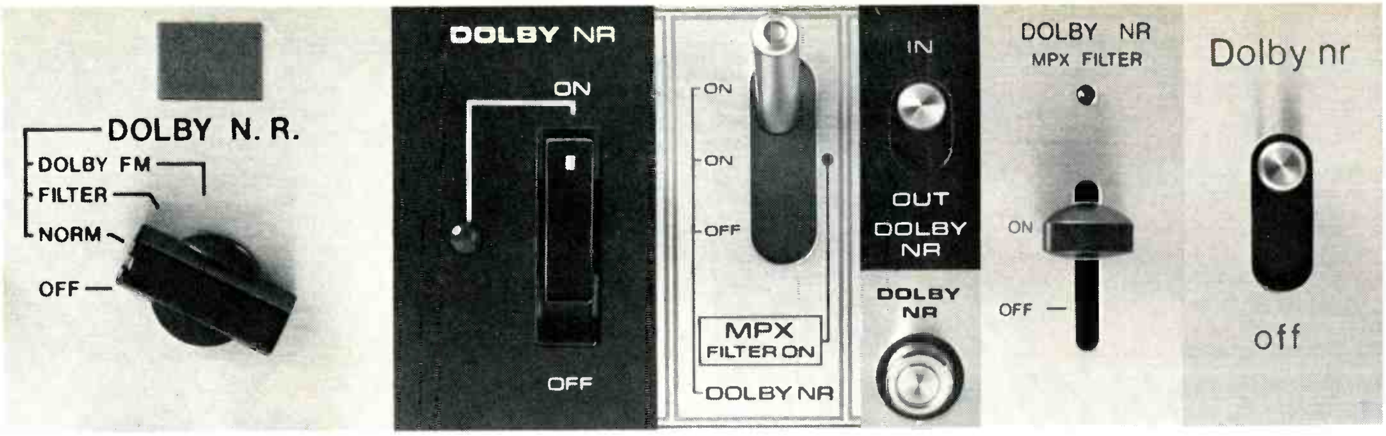
Primary and Secondary Ratings

IHF-A-202 details the method of measurement for many different ratings. All are not equally important nor do all apply to a specific type of amplifier. Some of them are preamplifier measurements. Some are power amplifier measurements. Some pertain to both. A list of the *primary* ratings, those that must be specified in order to claim an "IHF Specification," are listed in Table I for the three main categories of amplifiers. (The standard, by the way, applies equally to the amplifier section of a receiver, tuner/preamp, or self-powered loudspeaker.) All of the other ratings are part of the secondary disclosures listed in Table II. Many of these, we hope, will also be used by the industry.

Acknowledgments

The effort to produce the new standard was a long and arduous one. The task could not have been accomplished without the active efforts of the many committee members and without the support of the IHF. I'd like to take this opportunity to thank them on my own behalf for their diligence and unswerving dedication to the task. And I suspect that they would like to join me in the hope that the document that was produced will faithfully serve its purpose now and will serve to encourage future research and advancement in this industry.

IHF-A-202 is available from the Institute of High Fidelity, 489 Fifth Avenue, New York, NY 10017 for $7.50. Æ



When what's built-in is not enough.

Still hearing some "SSSSSSSS," even though you're using good tape and the noise reduction system in your deck? Don't blame the tape. Chances are, that noise reduction system doesn't have what it takes to give you totally noise-free recordings.

The answer: a dbx II tape noise reduction unit. All of our models give you 30 dB of noise reduction at all frequencies, plus 10 dB extra recording level headroom. Without altering the sound of your music, either. The best that Dolby* B can offer is 7-10 dB of noise reduction. Besides, Dolby and other typical systems operate only at high frequencies, allowing low frequency noises to remain. And as experts know, they require level matching. dbx II doesn't require any level matching whatsoever, because its true mirror image compression/expansion operates linearly on all frequencies and your music's entire dynamic range.

*Dolby is a registered trademark of Dolby Laboratories, Inc.

This all means that the live performances, FM broadcasts and record albums you tape will have their full dynamic range preserved, with no audible tape noise added. So, if you're unhappy with the noise reduction system in your tape deck, consider a dbx II. We make 3 models: the 122, for two-channel tape noise reduction; the 124 for four-channel tape noise reduction, or simultaneous off-tape monitoring of the noise-reduced signal; and the 128 combination tape noise reduction system/dynamic range expander, which lets you make tape copies of your recordings that sound better than the original.

The dbx difference is the difference between some tape noise and no audible tape noise at all. Hear it at your dbx dealer soon.

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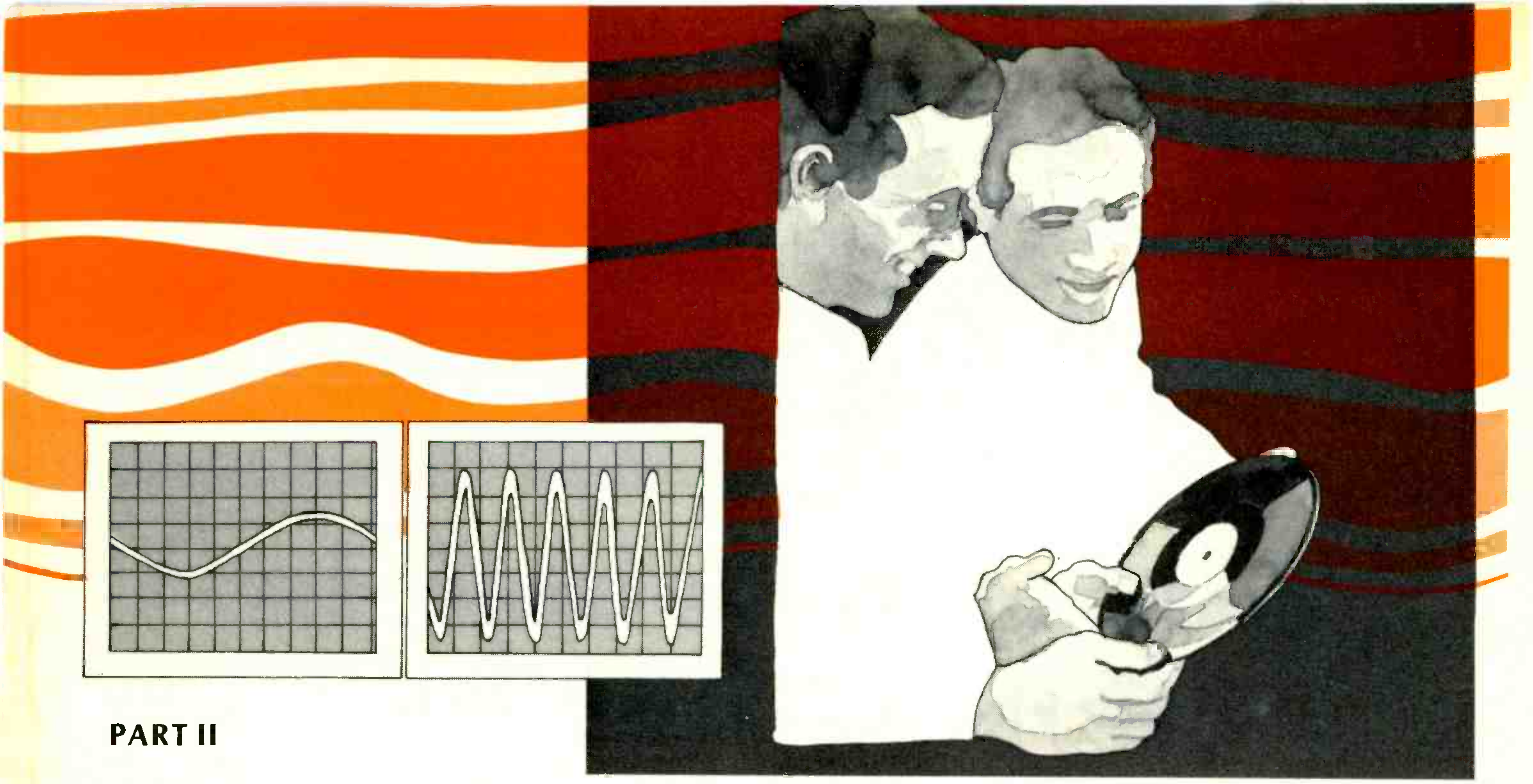


PART II

Phonograph Reproduction-1978

Roger Anderson, L.R. Happ, B.W. Jakobs, F.J. Karlov, James H. Kogen, and S.A. Mastricola.*

In the first part of this article, we discussed several important factors which must be considered in the phonograph playback process. We divided those factors into two categories, namely, those which relate to reproducing the modulation of the groove under ideal conditions, and, secondly, those which create practical problems in playback. Specifications which describe the performance of a cartridge under ideal conditions include frequency response, separation, trackability, and distortion. Principal practical problems are extremely high modulation levels, record warp, structure-borne noise, cartridge-tonearm resonance, static electricity, and the accumulation of contaminants on the record and stylus. It was shown that all of these practical problems can have serious and decidedly negative effects on sound quality.

The objective in designing a phonograph cartridge should be twofold. First and foremost, we must maximize the ability to play under ideal conditions. This requires that the cartridge have a flat frequency response that extends over the entire audible range. Trackability must be sufficient to handle all the program material found on records. Distortion should be below detectable levels, and crosstalk should not impair stereo balance. In addition to those performance factors, output level must be high enough to prevent signal-to-noise problems. Hum and r.f. pickup must be within acceptable limits. Finally, and of critical importance, the cartridge should play at tracking forces low enough to prevent rapid wear of both the stylus tip and the record surface. From our experience, tracking force should be below 1½ grams.

Since ideal conditions almost never exist, the second objective must be to reduce or eliminate the effects of non-ideal playing conditions. One obvious method is to provide a variety of accessory devices which may be used in conjunction with, or as appendages to, the cartridge-tonearm system. Many such devices are available that are meant to reduce the effects of mechanical noise, cartridge-tonearm resonance, static electricity, and record contamination. Such "add-ons" are almost never ideal design solutions since they lack the optimization derived from a total system design approach. The better solution is to provide a phonograph cartridge system that can operate without deterioration of its performance in the presence of non-ideal conditions. To design such a cartridge means a major expansion of objectives as compared to earlier designs.

The Shure V15 Type IV is the result of this new concept in phonograph cartridge design. Important improvements have been incorporated to better reproduce the modulation in the groove. In addition, features were added to resolve problems created by cartridge-tonearm resonance and static electricity, and also reduce the effects of dust accumulation. The difficulty of providing an integrated solution involving the resolution of several problems simultaneously has been considerable. In the remainder of this article, we will discuss some of the theoretical background which led to various of the design features and then describe the methods of solution.

Tracking Considerations

"Trackability" is the ability of the stylus to maintain contact with the record groove . . . across the frequency spectrum found on records. In addition to record modulation, many other

*** Anderson, Assistant Chief Engineer; Happ, Project Engineer; Jakobs, Director of Development and Application Engineering; Karlov, Manager of Electromechanical Development; Kogen, Vice President of Development and Design Engineering, and Mastricola, Senior Development Engineer.**

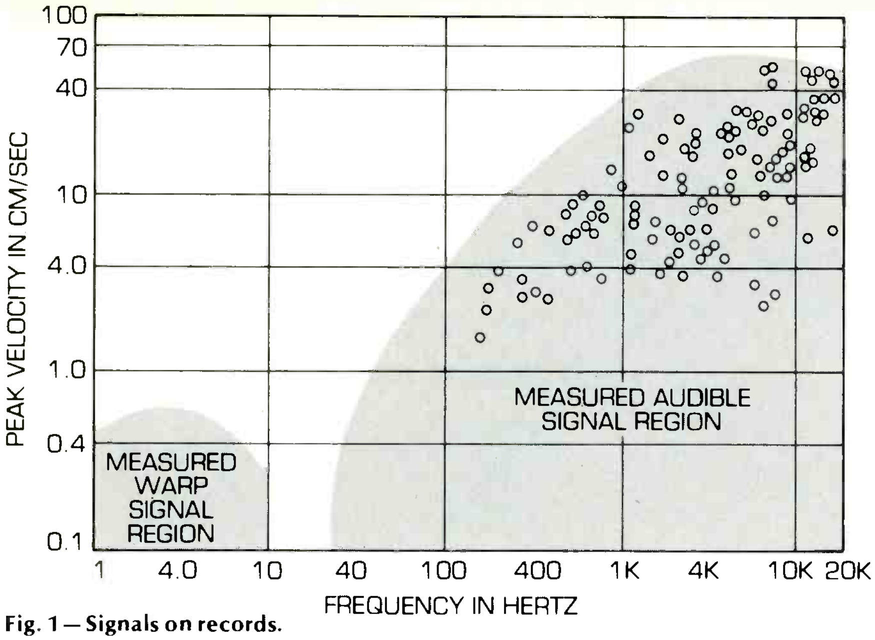


Fig. 1 — Signals on records.

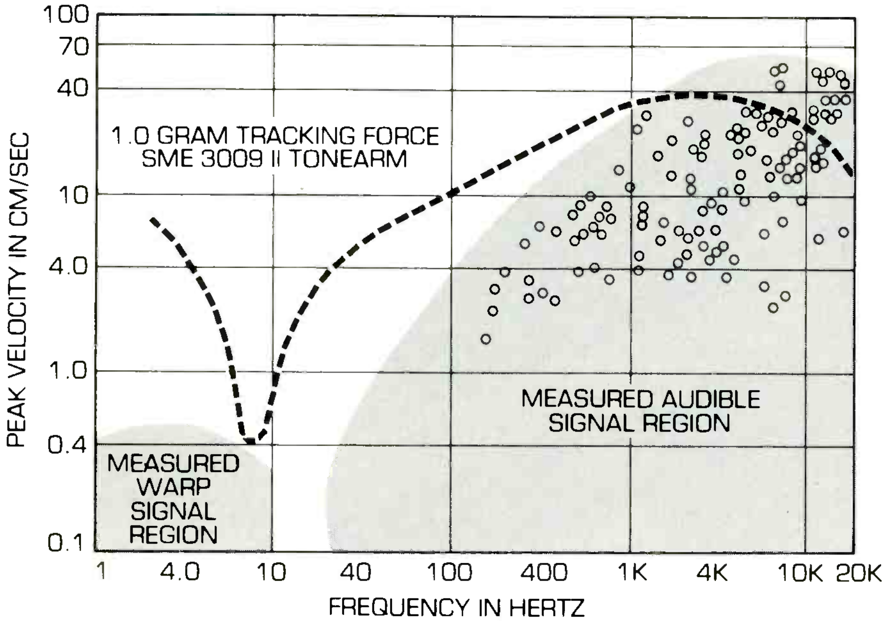
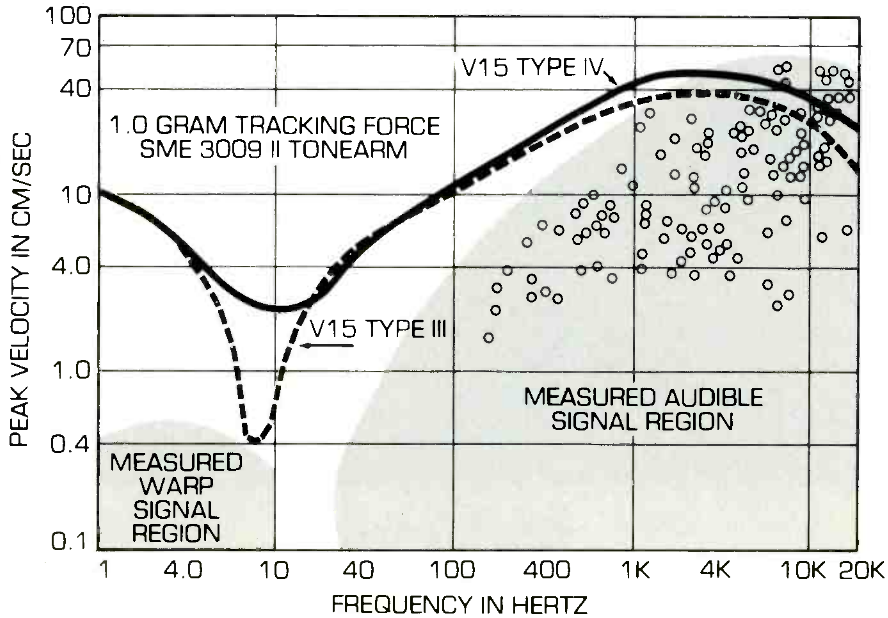


Fig. 2 — The V15 Type III phono cartridge system trackability.

Fig. 3 — The V15 Type IV phono cartridge system trackability.



signals are present on records in the form of unwanted disturbances. Our study of record warp characteristics shows that the distribution of these disturbance signals extends into the subaudible region (Fig. 1). By including warp signals, we can refer not only to the trackability demands of the pickup, but also to that of the tonearm and cartridge "system."

An example of the use of this procedure is shown in Fig. 2 for the V15 Type III in an SME arm at one gram tracking force. At frequencies where the trackability curve passes beneath the top limit of the signal distribution, the potential for mistracking exists. On records which contain these high peak signals, the V15 Type III, which possesses one of the highest high-frequency trackability of any present-day phono cartridge, should be played at its maximum recommended tracking force (1.25 grams) to track all signal levels. The remainder of the curve shows a trackability margin, illustrated by the clearance between the cartridge trackability curve and the shaded signal regions. Having a large trackability margin over only part of the frequency spectrum does not mean that the tracking requirement has been satisified. Ideally, a reasonable trackability margin should extend across the entire frequency spectrum.

The dip in the trackability curve of Fig. 2 is due to a resonance between the tonearm equivalent mass and cartridge compliance. The graph shows a significantly reduced tracking margin in the warp signal region (below 10 Hz). The curve in Fig. 2 suggests two regions where such trackability improvements would be desirable. The first is in the mid- and high-frequency regions, and the second is in the cartridge-tonearm resonance region where only a limited margin exists.

The goal for the V15 Type IV was to achieve improvements in both of these regions without compromising other specifications. The objective was to avoid giving up any low-frequency trackability for a gain at high-frequencies or an increase in the warp-signal rejection. A "brute force" approach often used is simply to overdamp the stylus and increase the rated stylus force. This approach was considered unacceptable. It was also considered unacceptable to trade off a flat frequency response for the sake of improved high-frequency tracking. It is only through this no-compromise approach that a real improvement in trackability can be achieved, not just a rearrangement within the present constraints. Significant improvement in

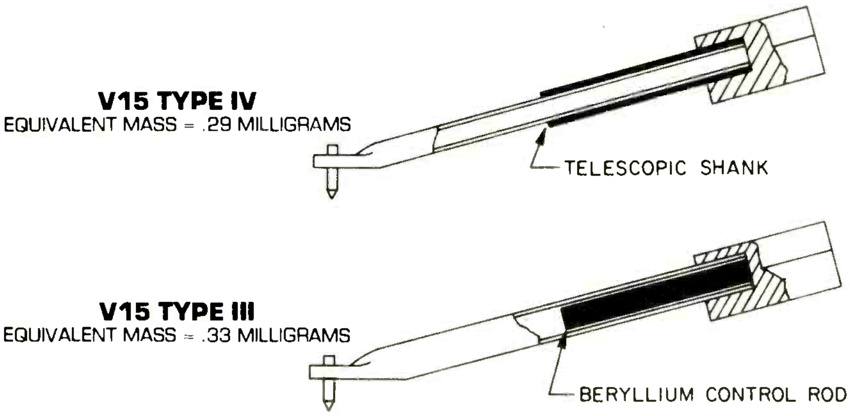


Fig. 4 — Phono stylus comparisons.

tracking ability was achieved as illustrated in Fig. 3 and Table I.

Table 1: Mid- and high-frequency trackability at 1-gram tracking force.

Frequency kHz	Peak Velocity cm/sec. V15 Type III	V15 Type IV
0.4	26	29
1	38	42
2		47
10	26	37

The greatest improvements were achieved in the high-frequency audio range and in the sub-audible warp-signal region. In the low audio frequencies, below approximately 100 Hz, the performance of the V15 Type IV is similar to the V15 Type III and, as the figure indicates, is more than adequate for commercial records. The dramatic improvement in the lower frequency region indicates a new, significant margin of protection against warp signals. The significance of this will be explained later.

We will now consider the means whereby improvements in the 20 Hz to 20 kHz range were achieved.

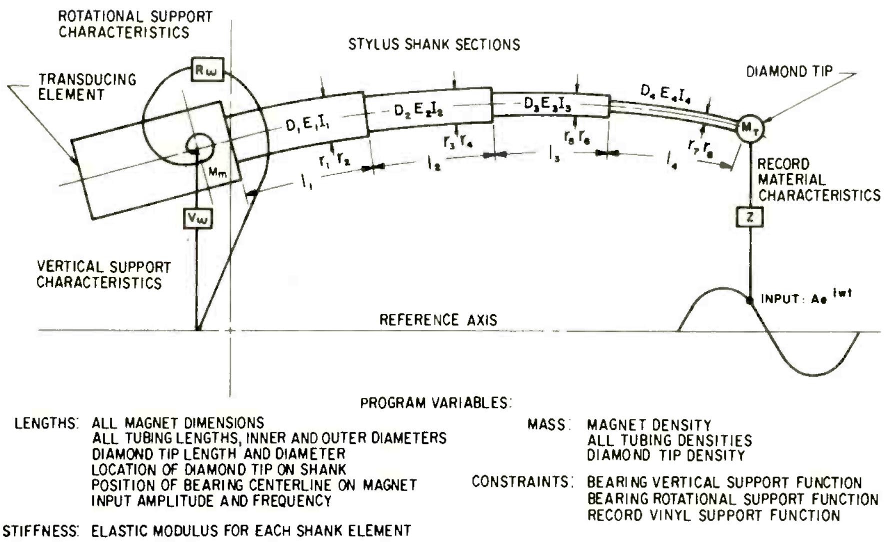
New Shank and Magnet Assembly

In a moving-magnet phono cartridge, the shank and magnet assembly is the heart of the transducer, and the design must evolve through a careful optimization process. It is necessary to have objective criteria which include low equivalent mass, a stylus resonance frequency above the audible range, low resonance Q, resistance to bending and fracture, and the proper geometry with respect to the stationary elements of the transducer to insure accurate signal transduction. Since many of these items lead to conflicting requirements, no one of these features can be maximized independently without affecting the others, or a less-than-optimum design would result. The engineer must evaluate each of these technical design factors and optimize them.

In the design of the V15 Type IV shank, a study was made that mapped out various aspects of the performance criteria. Through new computer techniques, many different shanks could be compared with respect to equivalent mass, impedance, flatness of response, stiffness, and physical geometry. Based on these results, many prototypes were constructed, measured, and subjected to extensive listening tests. The final design is called the "telescopic" shank and is shown in Fig. 4.

The telescopic shank employs a precision outer reinforcing tube in intimate contact with the shank. To achieve this critically tight assembly, new processes and highly specialized tooling were developed. The magnet is of a high-energy material that is reduced in both size and mass. By comparison, the V15 Type III uses a slightly larger diameter shank and an internal solid beryllium rod reinforcement. The net effect of these changes over the V15 Type III was to reduce the overall mass and equivalent mass of the stylus shank assembly, while maintaining similar overall geometry and bending strength. In terms of the performance criteria, the contribution of the new shank represents an improvement in high-frequency trackability, while maintaining a flat frequency response.

Fig. 5 — Phono stylus model used in computer simulation.



New Computer Model for Shank Evaluation

Although a new shank design is relatively easy to illustrate, the development of the shank was not an easy process. The description of one aspect of the project, a new computer model, which was used in the development of the V15 Type IV, will give some insight into the extensive engineering efforts behind such a development. The computer model is not an electrical-mechanical analog as discussed in past literature. The model is a mathematical derivation of the dynamic system shown in Fig. 5.

The model allows for mass and stiffness distributions that vary over the length of the shank; in fact, up to four separate sections can be pieced together to form a composite system. The supports, shown in the diagram as springs, represent record and bearing impedances which are each complex parameters determined from theory and empirical data. When given a

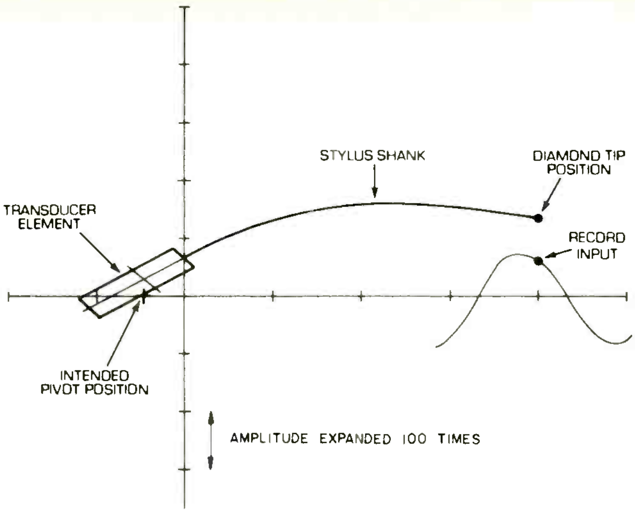


Fig. 6 — Phono stylus simulation — example 1.

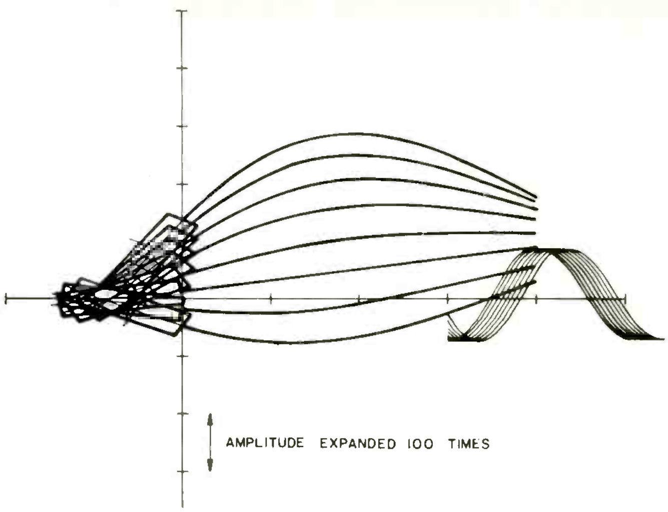


Fig. 7 — Phono stylus simulation — example 2.

sinusoidal input, the model can describe the stress or strain characteristics at any point within the system. Figure 6 illustrates the type of information the program can produce. The figure shows the centerline of a simple tubular shank at an instant of time during vibration at its resonance frequency. In this example, shank and bearing motion is uncontrolled due to the system's relatively high mass and inadequate damping in the bearing supports. The center of rotation of the transducing element has vibrated away from its intended pivot position on the reference axis. Figure 7 illustrates positions of the same stylus system at sequential instants of time. Note that in both Figs. 6 and 7 the vertical amplitude is shown magnified 100 times. The series represents ¼ of a full cycle at the stylus resonance frequency. Observe the mistracking from the input sine wave, shank flexing, and again, magnet motion away from the pivot point.

The computer analysis shows that tracking requirements necessitate a shank configuration which minimizes flexing. The materials employed, the shape of the shank as well as its length, width, and wall thickness all must be considered. In addition, some means must be provided to prevent movement of the pivot point.

During the development of the V15 Type IV, over 50 theoretical assemblies were simulated on the computer, and many were selected and built as experimental prototypes. Of these, a two-element, telescopic stylus shank structure was chosen which best suited and matched the bearing and vibration absorber assembly.

Bearing and Damping System

Development of the stylus shank is closely related to the bearing and damping system. All elements must be carefully integrated to achieve an optimum design. In addition to the constraints imposed by the stylus shank material, it is the bearing or properties of elastomers in general that must be optimized to maximize trackability over the entire signal spectrum. For example, if the stiffness of the bearing is reduced, improvements in trackability at low frequencies are generally achieved, but these are offset by reductions in high-frequency trackability. Therefore, if significant gains are to be made, it is necessary to examine the nature of the bearing materials and their contribution to trackability.

An investigation of bearing material was undertaken to study the relationship of stiffness and damping of various elastomers over the sub-audible and audible frequency spectrum. Using what is referred to as a mechanical impedance transducer, it is possible to discriminate between the forces within the material which are primarily "springlike" and those that most resemble a "dashpot" in character. A small cube of each material can be measured under stress/strain conditions that would be expected in the phono cartridge application. By measuring each test material over a wide range of frequencies, it is possible to generate the overall impedance characteristics of the material. By further processing this information, the dynamic stiffness and dynamic resistance characteristics of the materials can be determined. Thus, it is possible to measure the degree of both stiffness and damping as a function of frequency.

Ideal material qualities can also be defined. For example, the material should be stiff in the sub-audible region, compliant in the low- and mid-frequency region, and then stiff again in the very high-frequency region — not an easy requirement to satisfy! However, it was found that by a special compounding process, these characteristics can be blended together to produce qualities that more closely approach the ideal.

The overall material impedance characteristic, a combination of both material qualities, provides a parameter that relates to system trackability. Looking at this function, the V15 Type III and V15 Type IV bearing material characteristics can be compared in the sub-audible to mid-frequency range (Fig. 8). This graph shows the V15 Type IV bearing to have higher impedance in the very low audible (below 100 Hz) and sub-audible frequencies, yet less impedance in the mid frequencies. This is a desirable characteristic since it maintains proper compliance for optimum cartridge-tonearm resonance frequency and provides for improved mid-frequency trackability. High-frequency trackability is optimized with the dynamic vibration absorber.

The Dynamic Vibration Absorber

One of the compromises in designing the moving system of any phono cartridge has always been the conflicting requirements in achieving high trackability simultaneously in the low-, mid-, and high-frequency regions. As just stated, the demands upon the elastomer bearing are different for each part of the total spectrum. While the knowledge gained in measuring and blending the properties of elastomers allowed the engineer to more closely specify the optimum stylus system, it also showed that a single elastomer member, such as the conventional stylus bearing, could not ideally supply all the requirements over the entire frequency spectrum.

During the development phases of the Shure M24H Cartridge, designed for CD-4 quadraphonic as well as con-

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Now you have TX-4500MKII, the second generation AM/FM Stereo receiver with two phono inputs and three tape inputs plus tape-to-tape dubbing. And the Quartz-Locked tuning system which independent labs have called almost impossible to mistune.

To match the internal improvements, we've changed the layout of the TX-4500MKII, slanting both meters...Tuning and Signal Strength ...for easier reading. LED-indicated functions are more prominent and in full view at all times, protected by crystal-clear solid plate glass.

But most important of all, you still have the only Quartz-Locked tuning system available...Onkyo's. Assuring you of pinpoint frequency control without drift or distortion, based on the system's quartz crystal stabilized detector/corrector. Differential direct coupled amplifier circuitry delivers high power and exceptionally low distortion well beyond the range of audibility.

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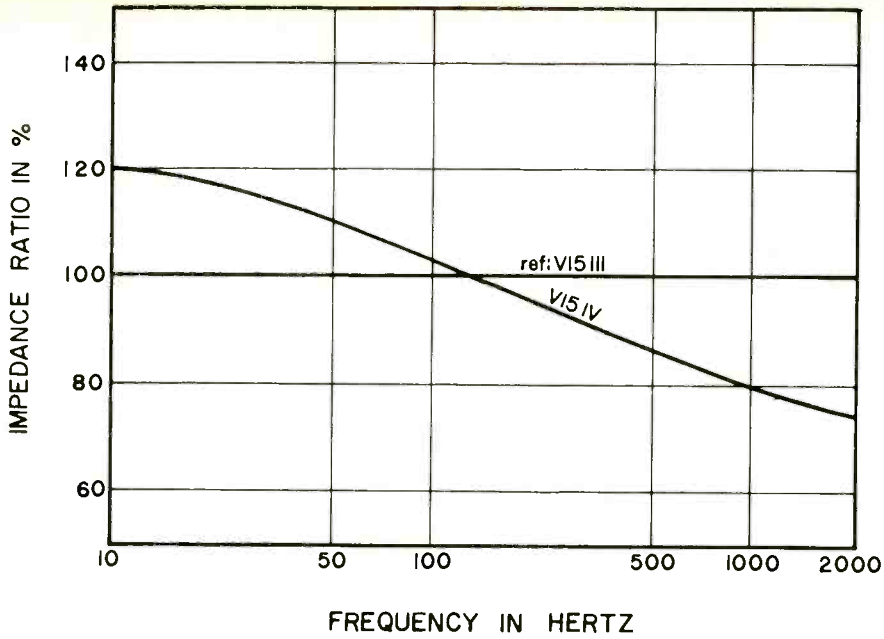


Fig. 8—Dynamic impedance comparison of the V15 Type III and Type IV bearing materials.

ventional stereo playback, there were additional requirements on the bearing to provide frequency response, trackability, and channel separation control through the carrier frequencies. It was at that time that Shure first applied the principle of the dynamic vibration absorber in a cartridge.

Figure 9 shows the initial embodiment of this approach in the development. A mass is attached to the end of the transducer magnet through a block of elastomer material, which has both the properties of compliance and damping. Above some preselected frequency, where additional damping is most beneficial, the mass element is such that its inertia prevents significant motion. The elastomer is vigorously exercised and its damping properties utilized. This effectively provides the additional damping only at the high frequencies where needed and not at low and mid frequencies where it is not desired.

Further exploration of the dynamic vibration absorber principle showed that a simpler, yet more functional, arrangement was possible. Figure 10 shows a structure which eliminates the lumped mass and takes advantage of the mass inherent in the elastomer itself. This distributed parameter structure allowed enhanced control of the initially conflicting compliance and damping requirements over the frequency spectrum. Its incorporation into the M24H design resulted in the desired carrier signal retrieval without record destruction while also allowing the M24H to perform as an excellent stereo cartridge.

The construction of the stylus and bearing system is shown in Fig. 11. The bearing and vibration absorber assemblies are designed to complement each other. The high-frequency mechanical resonance can be well controlled by the vibration absorber. With the bearing relieved of this function, it was possible to use a bearing material that improves tracking in the low- and mid-frequency regions. In the past, both of the functions were performed by a single part, but now each function can be independently optimized. One function of the support wire is to locate the fore and aft position of the pivot by preventing longitudinal stylus motion.

Frequency Response, Separation, and Loading

We feel very strongly that a flat response is ideal for a phonograph cartridge. Flat response in a linear system means that the output of the system is an exact reproduction of the input. This is a highly desirable objective in phonograph reproduction, for it assures the cartridge will be a neutral link in the audio chain. The curve shown (Fig. 12) is the typical response of the V15 Type IV. Also shown are the tolerance limits. Each cartridge is individually tested to ensure that this specification is met.

The proper loading to achieve this response is 47 kilohms, 250 pF. This is a change from previous Shure stereo cartridges in that the recommended capacitance has been reduced. This value of capacitance is typical of that available in present-day preamp inputs plus tonearm wiring. Use of the exact capacitance value is not critical since a range from 150 pF to 350 pF will keep the typical response within the published specifications. Therefore, in the vast majority of applications, response within the limits shown can be obtained without any adjustment.

All cartridges meet a specification of 25 dB minimum (30 dB typical) channel separation at 1 kHz and 15 dB minimum (20 dB typical) at 10 kHz.

Distortion

Distortion arises from many possible sources. We have discussed mistracking, the most serious cause of distortion and have described how it can be minimized through high trackability.

Figure 13 shows three types of distortion for the V15 Type II, III, and IV. Note that in all comparisons an improvement was achieved by each successive cartridge.

Two significant sources of distortion are the result of imperfect tracing and the mismatch of tracking angles.

Fig. 9—Lumped-parameter stylus construction.

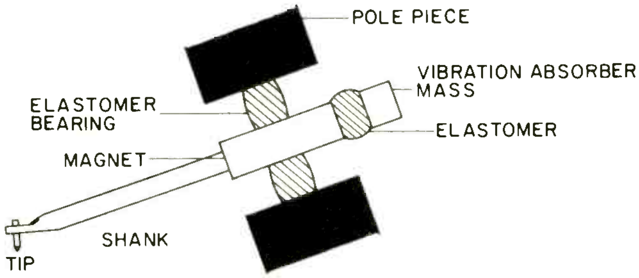
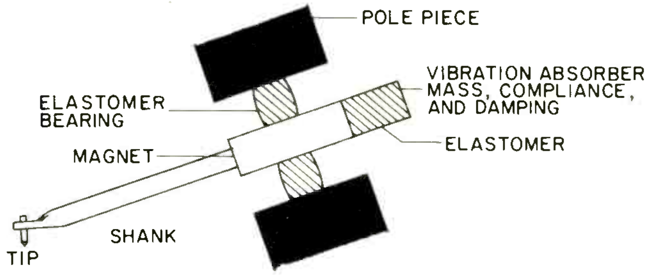


Fig. 10—Distributed-parameter stylus construction.



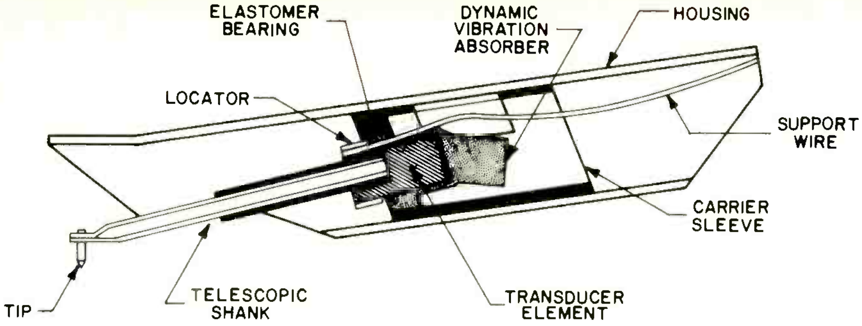


Fig. 11 — V15 Type IV stylus assembly.

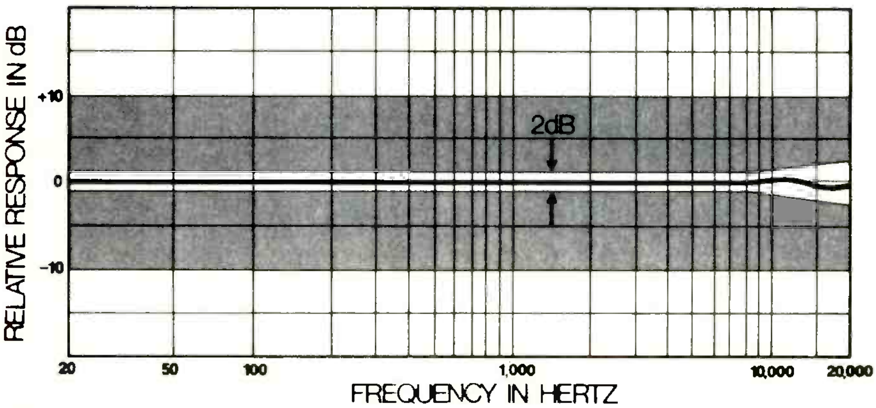


Fig. 12 — The V15 Type IV typical frequency response envelope.

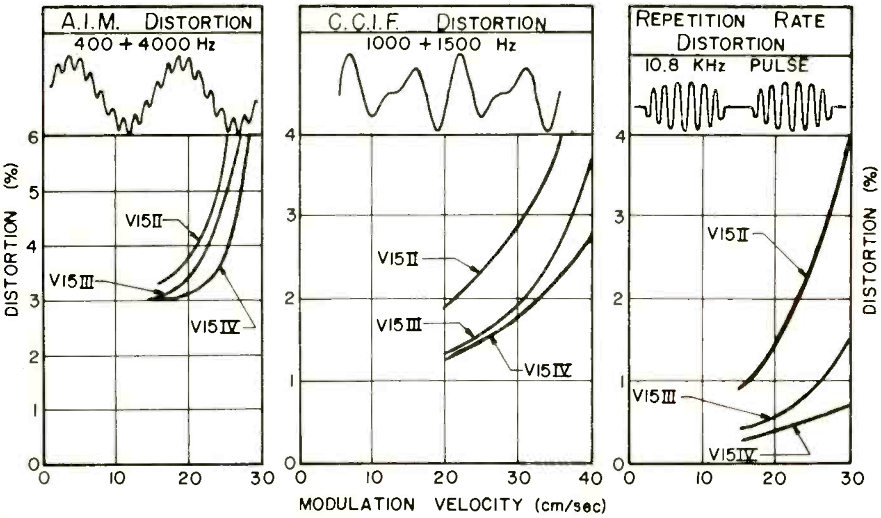
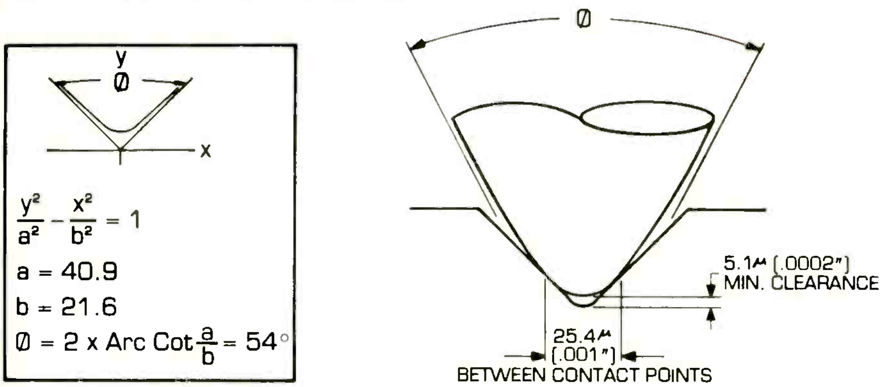


Fig. 13 — Comparative distortion data with the Shure TTR 103 test record and the stylus force at 0.75 grams.

Fig. 14 — Hyperelliptical stylus tip frontal profile.



Tracing Distortion

This type of distortion relates to the size and geometrical configuration of the tip. Here we will only summarize some significant conclusions. Four criteria were considered: tracing distortion, tip life, record wear, and noise generation. Distortion decreases as the tracing radius of the tip is reduced. The limit to size reduction is reached when the record wear and noise increase significantly. Record wear is also related to tracking force and, very significantly, to trackability. Thus, there are several interlocking considerations. Our tests indicate that the minimum practical tracing distortion at this time is that which results from the use of a playing radius of 0.0002 inch (5 microns). In order to employ such a playing radius, tracking capability must be very high and tracking force must be lower than 1.5 grams. The maximum tracking force for the V15 Type IV is specified at 1.25 grams, well below the desired maximum of 1.5 grams. At this time we have no measured evidence that the use of a long-contact-area stylus can allow this criterion (i.e. playing at over 1.5 grams) to be exceeded without affecting record life.

The requirements of a tip for the V15 Type IV were considered in the examination of tips of many geometries. A variety of requirements for performance, including low distortion, noise, and wear, resulted in the design of the hyperelliptical tip (Fig. 14).

The Hyperelliptical Tip

There is nothing that is harder and more wear-resistant than natural diamond. These hyperelliptical tips are made from gem-quality, natural diamonds, i.e., they must be of high purity and be free of inclusions or crystalline defects. This ensures that they will survive the high stresses applied during the many manufacturing operations necessary to achieve the critical contour and side radii and will also provide a relatively low wear rate during playback.

The basic frontal contour is a hyperbola described by $y^2/40.9^2 - x^2/21.6^2 = 1$ (Fig. 14). It is generated by a manufacturing process involving intersecting cones. The frontal contour is approximately equal to 38μ (0.0015 inch) radius in the groove contact region. The curvature has been carefully optimized and allows a certain degree of freedom for angular tolerances without degradation of performance.

A minimum clearance of 5.1μ (0.0002 inch) from the bottom of the groove is required. The tip must never

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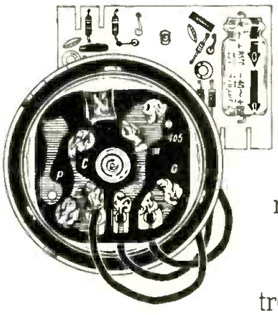
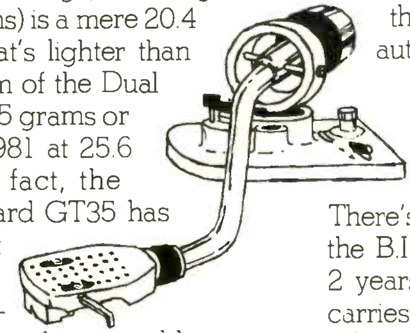


Start with the motor. The Dual 1245 features a fine 8 pole, synchronous motor and the B.I.C. 981, a 24 pole, synchronous unit.

The new Garrard GT35 incorporates a servo-controlled, DC motor. Servo control provides absolutely steady speed. The motor, (and thus the rotation of the platter), is immune to fluctuations in household voltage or frequency. Len Feldman, writing in *Radio Electronics*, reviewed it as a "significant breakthrough" superior to the "synchronous motor however many poles it might have." The GT35 is the only, belt-driven, single/multiple play turntable in the world with a servo-controlled, DC motor.

Chalk one up for the new Garrard GT35.

Now for the tonearm. Remember that the delicate stylus, as it traces the groove, bears the full weight of the tonearm. The heavier the tonearm, the greater the wear on the record and stylus. Light is right. The effective mass of the GT35 tonearm (measured with a Shure M95ED cartridge, tracking at 1¼ grams) is a mere 20.4 grams. That's lighter than the tonearm of the Dual 1245 at 27.5 grams or the B.I.C. 981 at 25.6 grams. In fact, the new Garrard GT35 has the lightest tonearm of *any* single/multiple play turntable.



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Tonearm control is by simple rotary action. It's no wonder that *Radio Electronics* said, "...the pick-up arm is handled more gently than could be done by the steadiest of hands."

We make this claim: Delglide is the smoothest and quietest automatic system ever incorporated in a turntable — of any kind.

That's still another one for the new GT35.

There's more. The Dual 1245 and the B.I.C. 981 are warranteed for 2 years. The new Garrard GT35 carries an unprecedented 3 year warranty. That's our way of underscoring its exceptional reliability. 53

Finally. The price advertised by the manufacturer. Including the base and dust cover, the Dual 1245 is $240 and the B.I.C. 981, $237. The price of the new Garrard GT35: just $219.95.

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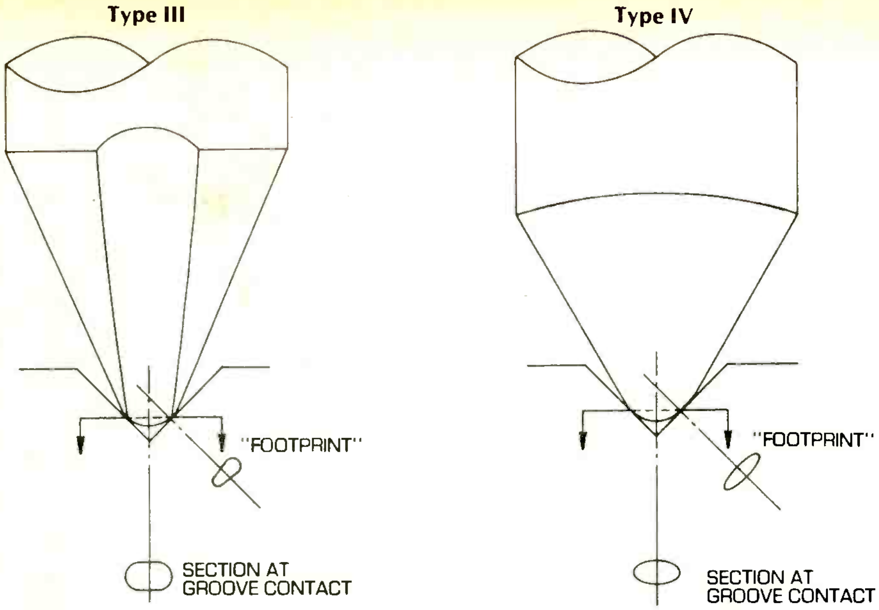

Fig. 15—Comparison between the V15 Type III biradial tip and the V15 Type IV hyperelliptical tip.

"ride" in the bottom of the groove since this will result in objectionable noise. The elongated contact area permits a narrower, but longer "footprint" in the groove wall, thereby reducing distortion (Fig. 15). The tracing radius is smaller for lower tracing distortion (Fig. 15), and it has an elliptical cross section that assures uniformity along the contact length.

The tracing radius is also smaller throughout, not just at the theoretical point of contact. By virtue of a patented manufacturing technique, the contact radius remains uniform along the entire contact length, an improvement over spherical, biradial, and some of the conventional long-contact varieties. The desired geometry is a natural outcome of the manufacturing process. Notice that, even though the tracing radius is smaller, the contact area is not; it is just shaped differently. Therefore, we have the advantage of more accurate tracing without decreasing the contact area. This is an important point in that the contact area is related to the amount of indentation and stresses within the groove wall, which probably influence record wear.

Measurements

The design just described satisfies several functional and practical manufacturing requirements. However, the tip must be tested in the cartridge itself to determine whether it performs dynamically. Extensive testing is done to check the design and performance under dynamic conditions. This type of testing includes distortion measurements, noise and wear measurements,

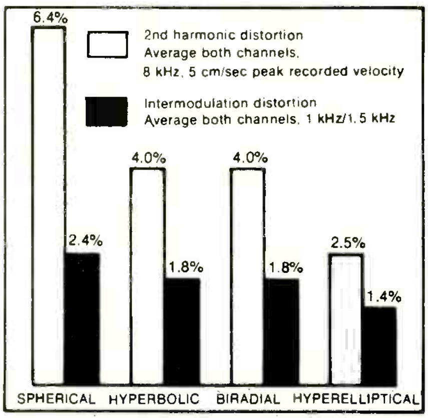

Fig. 16—Harmonic and intermodulation distortion for various tip shapes.

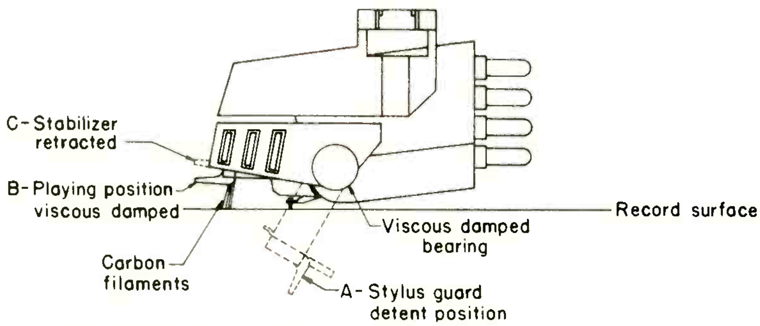

Fig. 17—Destaticizer stabilizer positions.

and visual observations of tips and records in conjunction with controlled tests.

A) Distortion Measurements: The dimensions of the hyperelliptical tip theoretically indicate that it will trace the signal more accurately than its predecessors. Tests performed which verified this are as follows (Fig. 16):

1) Second harmonic distortion was measured using the V15 Type IV cartridge with the CBS STR-100 test record on bands 3A and 3B with a 8-kHz signal @ 5 cm/sec. peak velocity at a tracking force of 1.25 grams. Average values of *both* channels for *several* cartridges are as follows: a) spherical (0.6 mil), 6.4 per cent; b) biradial (0.3 x 0.7 mil), 4.0 per cent; c) hyperbolic, 4.0 per cent, and hyperelliptical, 2.5 per cent.

2) IM distortion was measured with the V15 Type IV cartridge on the TTR103 test record, band 6, with a 1 & 1.5 kHz signal @ 25 cm/sec. peak velocity at a tracking force of 1.25 grams. Average values of *both* channels for *several* cartridges are as follows: a) spherical (0.6 mil), 2.4 per cent; b) biradial (0.3 x 0.7 mil), 1.8 per cent; c) hyperbolic, 1.8 per cent, and hyperelliptical, 1.4 per cent.

These data show two different types of distortion measurements under two different sets of conditions. The numbers change, but the trend is clearly the same. The hyperelliptical tip yielded lowest distortion values in each case. Since the tests were conducted under different conditions, there is a strong indication that the results are not unique to one case but are valid for a wide variety of situations in which a valid difference would result.

In all of the preceding measurements, great care was taken to assure that the test conditions remained the same for all styli. Tracking force and skating force were set for each stylus. A new record was used for *every* stylus. The measurements were repeated to demonstrate that the results were repeatable and consistent. All of these precautions must be taken to obtain meaningful data that is repeatable. Even with these precautions, we still occasionally find individual styli that do not fit the pattern. We must remember that distortion measurements are measuring more than just the distortion caused by the tip. Therefore, it is necessary to test many units in order to arrive at valid conclusions.

B) Noise Measurement: Tests were conducted to determine the effect of the hyperelliptical tip on surface noise. The cartridge was a V15 Type IV on a 33⅓ rpm record with a radius of 3 inches, tracking unmodulated (silent)

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Precision Molded Cassette Shells—are made by continuously monitored injection molding that virtually assures a mirror-image parallel match. That's insurance against signal overlap or channel loss in record or playback from A to B sides. Further insurance: high impact styrene that resists temperature extremes and sudden stress.

Five-Screw Assembly—for practically guaranteed warp-free mating of the cassette halves. Then nothing—no dust or tape snags—can come between the tape and a perfect performance.

Perfectly Circular Hubs and Double Clamp System—insures there is no deviation from circularity that could result in tape tension variation producing wow and flutter and dropouts. The clamp weds the tape to the hub with a curvature impeccably matched to the hub's perimeter.

An Ingenious Bubble Surface Liner Sheet—commands the tape to follow a consistent running angle with gentle, fingertip-embossed cushions. Costly lubricants forestall drag, shedding, friction, edgewear, and annoying squeal. Checks channel loss and dropouts.

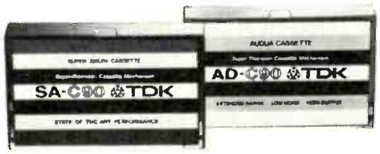
Head Cleaning Leader Tape—knocks off foreign matter that might interfere with superior tape performance, and prepares the heads for...

Tapered, Flanged Rollers—direct the tape from the hubs and program it against any up and down movement on its path towards the heads. Stainless steel pins minimize friction and avert wow and flutter, channel loss.

Our famous SA and AD Tape Performance—two of the finest tapes money can procure are securely housed inside our cassette shells. SA (Super Avilyn) is the tape most deck manufacturers use as their reference for the High (CrO_2) bias position. And the new Normal bias AD, the tape with a hot high end, is perfect for any type of music, in any deck. And that extra lift is perfect for noise reduction tracking.

Resilient Pressure Pad and Holding System—spring-mounted felt helps maintain tape contact at dead center on the head gap. Elegant interlocking pins moor the spring to the shell, and resist lateral slipping.

TDK Cassettes—despite all we put into them, we don't ask you to put out a lot for them. Visit your TDK dealer and discover how inexpensive it is to fight dropouts, level variation, channel loss, jamming, and other problems that interfere with musical enjoyment. Our full lifetime warranty* is your assurance that our machine is the machine for your machine. TDK Electronics Corp., Garden City, N.Y. 11530. Canada: Superior Electronics Ind., Ltd.



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grooves with a tracking force of 1 gram using a high-pass filter from 500 Hz with the frequency response on each stylus equalized to be like all other styli within 1 dB. The results for average wide-band noise output on initial play on *both* channels for *several* cartridges relative to the 1-kHz level @ 5 cm/sec. peak velocity were a) biradial (0.3 x 0.7 mil), −46¾ dB, and b) hyperelliptical, −47½ dB. The above difference is not significant and shows that the hyperelliptical generated about the same acceptably low surface noise as the conventional biradial tip.

C) Wear: Comparative tests were conducted to evaluate tip and record wear. In one test V15 Type IV styli with biradial, hyperbolic, and hyperelliptical tips were played continuously on the Shure TTR110 record at 1.25-grams tracking force. All cartridges were mounted in the same model record changer. The tips and records were cleaned regularly. Based on photographs of the tips, no significant difference in the rate of tip wear was observed in these tests.

Record wear tests were conducted as well. Second harmonic distortion was measured after 100 plays. The results showed no significant difference among biradial, hyperbolic, and hyperelliptical tips.

Although extensive testing has been performed on noise generation, record wear, and tip wear, we have found little in the way of significant differences among tips of different shapes. We have confirmed that playing at higher tracking force accelerates wear and recommend a force of no more than 1.5 grams. We have also confirmed, once again, by measurement that mistracking is disastrous in terms of noise and record wear.

Tracking Angle Distortion

Of the two types of tracking angle distortion, that which applies to the cartridge relates to the vertical tracking angle (VTA). Much has been written on that subject but, unfortunately, no standard exists either in the way records are cut or in their method of measurement. Unofficially, a 15° VTA is called for in the U.S. and 20° in Europe. Without a standard measuring means, however, we cannot determine whether these angles are being employed in records or not.

Although a universal standard VTA for the cutting of records does not exist, we do specify the geometrical vertical tracking angle of the cartridge. This is to be distinguished from the effective VTA of the cartridge during playback. The latter must best be determined by a suitable test record. Since a standard, universally accepted test record does not yet exist, the only vertical tracking angle specification that can be stated with reasonable certainty is the geometrical vertical tracking angle. This angle may be derived from layout drawings and from measurements of actual piece parts in the assembly. The available test record means include a second harmonic distortion method—test record CBS STR-160, intermodulation distortion method—test record RCA 12-5-78, and intermodulation distortion method—test record DIN 45 542. Extensive measurements using each of these test records indicate significant differences among these techniques. Specifically, the RCA and DIN test records can yield measured vertical tracking angles as much as 5° higher than those obtained using either the geometrical method or the CBS STR-160 test record. In addition, a variation of approximately 3° is obtained from two different test bands on the DIN 45 542 test record. The geometrical vertical tracking angle of the V15 Type IV was designed not to exceed 23° to insure that it will meet the DIN specification of 20° ±5°.

Dealing With Non-Ideal Conditions

Our discussion has dealt with factors relating to playback under ideal conditions. We have also described how to improve trackability to handle extremely high-level modulation. As stated earlier, conditions are almost never ideal. We will now describe means of dealing with the major phenomena that create a non-ideal playing situation.

Cartridge-Tonearm Resonance, Warps, and Structure-borne Noise: An ideal method to control the cartridge-tonearm resonance should incorporate the following considerations: 1) the arm should be free to follow very low-frequency input—warps, spiral groove, banding, etc.; 2) the response of the system should include all program material and reject undesired outputs; 3) any damping system employed should suppress the resonance so that undesired low-frequency inputs are not magnified, and 4) the damping means should not affect the stylus centering when banding or groove pitch changes are encountered.

The Shure V15 Type IV provides a unique and practical solution to the problem of damping low-frequency cartridge-tonearm resonance. This has been accomplished in conjunction with several other features and without sacrificing any operating characteristics.

The system uses a structure called the Dynamic Stabilizer. The stabilizer, shown in Fig. 17, displays two unique features. The first is a graphite-filament structure located on the bottom-front edge of the stabilizer, and the second is the viscous-damped bearing system which replaces the standard stylus-guard pivots.

Position "A" shows the stabilizer detented downward and functioning as a stylus guard. Position "B" is the normal playing position. The graphite filaments contact and "ride" the record surface, and the viscous damping of the bearings controls the vertical resonance. Note that the stabilizer filaments are placed as close to the stylus as possible; this is a critical factor in insuring that motions from warps are applied to both the stylus and stabilizer simultaneously. The net result of this action is that the tonearm closely follows the irregularities of the record and minimizes warp effects on the stylus.

The V15 Type IV has a stylus tracking force range of ¾ to 1¼ grams and the Dynamic Stabilizer exerts a ½ gram force on the record surface. Thus, the total arm force is set between 1¼ and 1¾ grams. In position C, the stabilizer is retracted, and the fibers do not touch the record surface. Record play in this case is in the conventional manner, and the tracking force is set for the stylus range of ¾ to 1¼ grams.

The choice of small diameter graphite fibers was made for several reasons. In addition to excellent functional properties, such as a damping contact, the fibers are electrically conductive, picking up static electricity on the record surface and discharging it to ground. Because static electricity on the record can attract the arm and pickup, the fibers serve to stabilize the tracking force during record play. (The static discharge takes place—though less effectively—even when the stabilizer is in position C.)

The graphite fibers also function quite efficiently as a record-cleaning brush. Each strand is only 7.6 microns in diameter, enabling it to sweep the record grooves free of loose dust and prevent the grinding of dust into the groove walls.

Still another feature of the stabilizer is its function as a shock absorber. When the arm is accidentally dropped, a conventional stylus assembly receives the full shock upon contact. Permanent damage may result and the stylus may even become inoperative. In addition, the springiness of the stylus may cause it to bounce across the record and damage the grooves. In normal operation—i.e. position B—

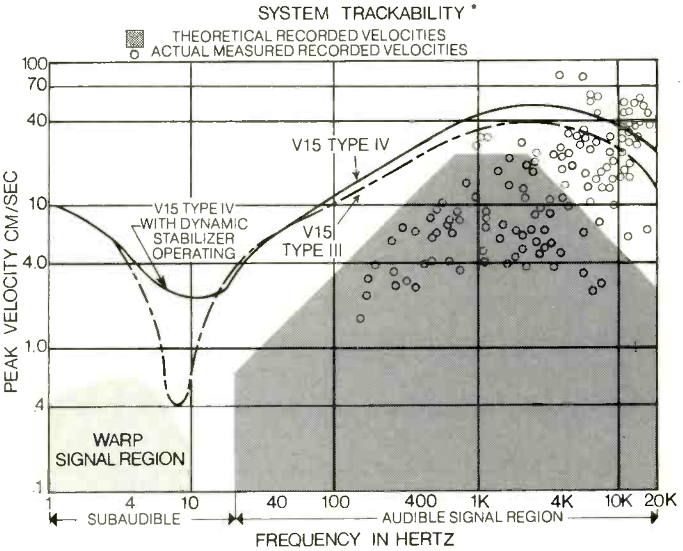
fact:
the IV does more... *much more!*

The creation of the new V15 Type IV is a tour de force in innovative engineering. The challenge was to design a cartridge that would transcend all existing cartridges in musical transparency, technical excellence, and uniformity. The unprecedented research and design disciplines that were brought to bear on this challenge over a period of several years have resulted in an altogether new pickup system that exceeds previous performance levels by a significant degree—not merely in one parameter, but in totality.

In fact, this pickup system has prevailed simultaneously over several extremely difficult music re-creation problems which, until now, have defied practical solutions. Most of all, this is an eminently musical cartridge which is a delight to the critical ear, regardless of program material or the rigorous demands of today's most technically advanced recordings.

THE V15 TYPE IV OFFERS:

- Demonstrably improved trackability across the entire audible spectrum—especially in the critical mid- and high-frequency areas.



*Cartridge-tone arm system trackability as mounted in SME 3009 tone arm at 1 gram tracking force.

- Dynamically stabilized tracking overcomes record-warp caused problems, such as fluctuating tracking force, varying tracking angle and wow.
- Electrostatic neutralization of the record surface minimizes three separate problems: static discharge; electrostatic attraction of the cartridge to the record; and attraction of dust to the record.
- An effective dust and lint removal system.
- A Hyperelliptical stylus tip configuration dramatically reduces both harmonic and intermodulation distortion.
- Ultra-flat response—individually tested to within ± 1 dB.
- Lowered effective mass of moving system results in reduced dynamic mechanical impedance for superb performance at ultra-light tracking forces.

For more information on this remarkable new cartridge, write for the V15 Type IV Product Brochure (ask for AL569), and read for yourself how far Shure research and development has advanced the state of the art.

SHURE®

Shure Brothers Inc., 222 Hartrey Ave., Evanston, IL 60204 In Canada: A. C. Simmonds & Sons Limited
Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

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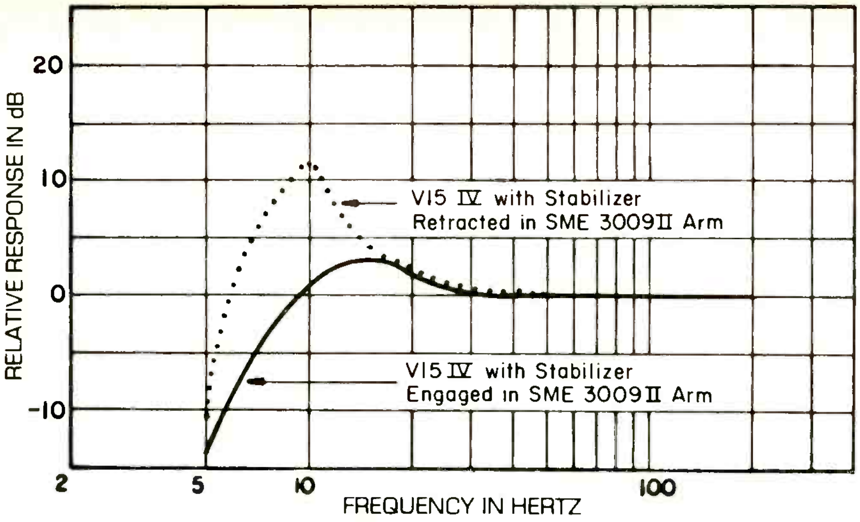


Fig. 18—Low-frequency vertical response of the V15 Type IV STR 120 @ 16⅔ rpm through integrator.

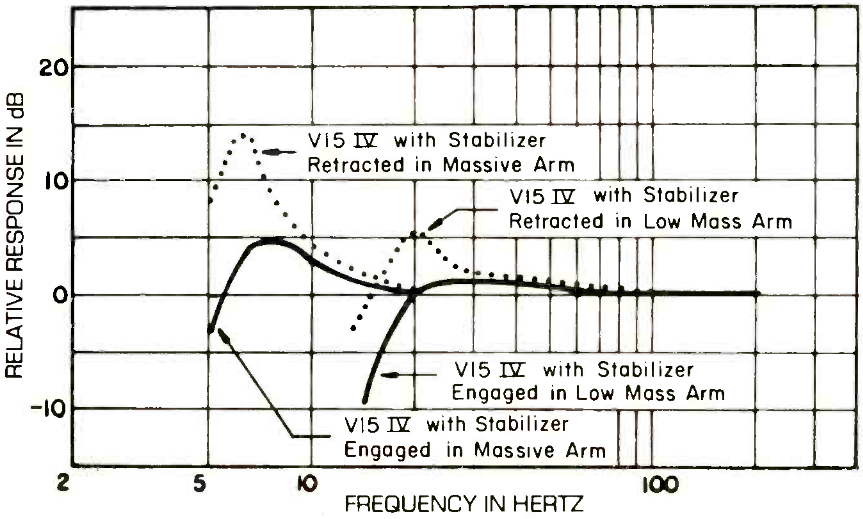
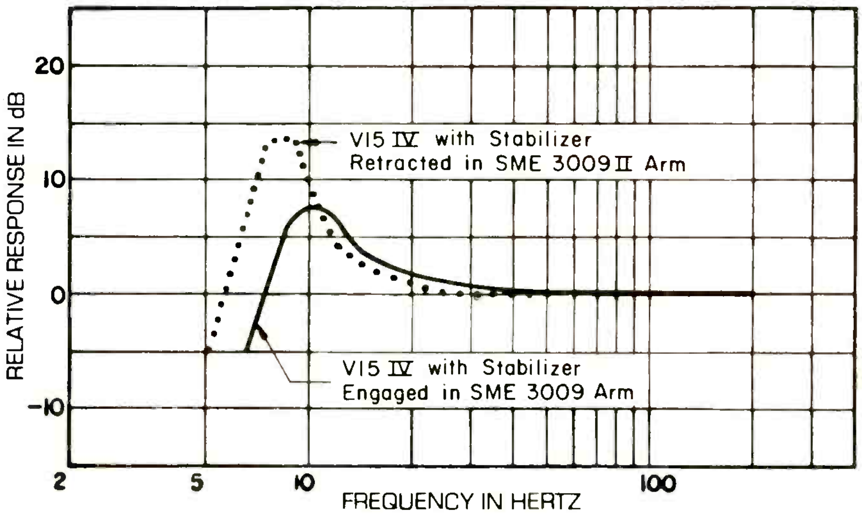


Fig. 19—Low-frequency vertical response of the V15 Type IV STR 120 @ 16⅔ rpm through integrator.

Fig. 20—Low-frequency lateral response of the V15 Type IV STR 120 @ 16⅔ rpm through integrator.



the viscous-damped stabilizer cushions the impact of the drop and prevents bouncing.

Thus, the V15 Type IV provides solutions to a number of phono equipment problems. The Dynamic Stabilizer not only effectively solves the problem of low-frequency stability, but also offers virtual freedom from static electricity, record surface dust, and impact damage.

Stabilizer Control of Cartridge-Tonearm Resonance: A convenient way to measure the effectiveness of the stabilizer is to run the low-frequency response curve. An STR-120 record played back at half speed will produce a sweep from 5 to 250 Hz, nicely covering the cartridge-tonearm resonance frequencies. The record is cut with a constant amplitude characteristic, and this is shown in Fig. 18 as the flat zero axis. The measurement is made through an integrator which causes the output of the cartridge to correspond to the amplitude of the relative motion between stylus and cartridge body. The dotted curve shows the response of a V15 Type IV in an SME arm Series II with the stabilizer retracted. Note that the arm resonance causes an 11-dB increase in output at 10 Hz. When the stabilizer is engaged, the peak is effectively damped to less than 3 dB. At still lower frequencies, the response falls off rapidly, corresponding to frequencies at which the cartridge-tonearm assembly moves as a whole.

In Fig. 19, the effects of mounting the V15 Type IV in both a very light and a very heavy arm are shown. The equivalent mass of the light arm without cartridge is about two grams, which is about the practical minimum. Here, the stabilizer removes the 6-dB peak which represents the best that can be accomplished with a cartridge with a mass of five grams. The heavy curve is run in an undesirably massive arm, and even here there is a reduction of approximately 8 dB below the 14 dB that would otherwise be present.

An informal way of demonstrating the effectiveness of the stabilizer is to drop the cartridge on a record from a ½ inch height. The pickup will practically attach itself to the record at the point of first touchdown, instead of showing the bouncing, skating behavior observed with non-stabilized cartridges.

Since the stabilizer works principally in the vertical mode, it is not unexpected that the lateral resonance shows smaller changes, which are shown in Fig. 20. Even here, the effect of increased stiffness and damping may be seen as the response peak is shifted to a higher frequency with con-

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The specifications of your cassette deck may look outstanding. But its actual performance — the quality of your music reproduction — can only be as good as the tape you use. To ensure optimum performance, all of the time, you need Fuji cassettes.

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Versatility. The new Fuji FX-I 120μs normal-bias formulation is ideal for use with home, portable and car decks; because Fuji FX-I is completely compatible with every normal-bias machine.

Bias Acceptability. To ensure perfect compatibility between your machine's factory-set bias and your tape, you need a tape with a wide range of bias acceptability. Like the new Fuji FX-II 70μs Beridox cassette. Its bias latitude is much greater than most other high-bias formulations.

Wow and Flutter. The friction created by conventional cassette housings may adversely affect the wow and flutter performance of your cassette machine. So Fuji designed a new housing for the FX-I and FX-II tapes. With unique teflon coated waffled slip sheets, convex guide rollers (for more accurate tracking) and improved pressure pad, the new Fuji housing substantially reduces friction.

So to get the best possible performance from your cassette machine, to make your music sound clean, clear and crisp, visit your Fuji dealer today. Tell him you want to upgrade your hi-fi. Tell him you're ready to Fuji-Fi.

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siderably less peaking. However, as mentioned earlier, the need for reduction of the lateral resonance is minimal compared to the need for vertical control, since a record would not have lateral warps and the structure-borne noise is principally vertical.

A critical factor in the design and application of the dynamic stabilizer is that of minimizing noise generation. Several features were incorporated in the design to guarantee that noise would be insignificant. A specification of at least 6 dB below typical values of groove echo puts the noise well below the noise level of commerical discs.

Control of Static Electricity

As mentioned in Part I, variable attraction of the cartridge to the record can seriously effect sound quality. Because static electricity is such a persistent and erratic problem, it was felt that the V15 Type IV should incorporate an effective means of nullifying its influence. The Dynamic Stabilizer incorporates a bundle of graphite fibers bonded to a metal carrier, which, in turn, is pivoted on the stylus grip. Thus, the fibers wipe the charges from the grooves which are about to be played. Care has been exercised to maintain a conductive path through the fibers, carrier, bearings, and stylus grip to cartridge ground. The surface of the record, therefore, is effectively grounded through the stabilizer during playback.

Even in the "up" position and not contacting the record, the fibers perform a destaticizing function, reducing the threshold voltage (see Part I) to about half the level it would otherwise attain. In playing position, the Dynamic Stabilizer reduces even a strong charge to negligible proportions in the course of playing a record. Since the carbon filaments are offset toward the center of the record, charges are removed before the stylus reaches the portion of the groove to be played.

A record initially charged on both sides and played on one side will experience a reappearance of the charge on the record's underside when it is removed from the turntable. This is due to the electrostatic field concentrated under the record while on the turntable and not available to the Dynamic Stabilizer.

In addition to destaticizing the playing surface, the graphite fibers are effective in sweeping dust particles from the grooves before the stylus reaches them. The absence of static charges makes the sweeping job much more effective than non-conductive bristles and their resulting charges would produce.

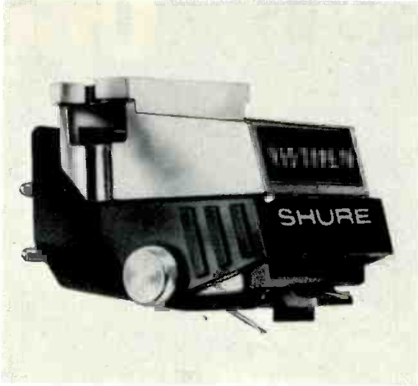


Fig. 21 — The Shure V15 Type IV Stereo Dynetic phonograph cartridge.

Thus, we feel that our investigation has resulted in a phonograph cartridge system (Fig. 21) which effectively deals with the problems caused by static electricity. Eliminating discharges and electrostatic attraction — making dust and particle removal much more effective — and stabilizing the arm against spurious excitation have resulted in a significant improvement in record reproduction.

Summary and Comments on the Future

We have considered two aspects of phonograph reproduction, playback of the modulation in the groove under ideal conditions and the effects of practical, non-ideal conditions. Playback under ideal conditions presents some very challenging requirements including tracking over a broad dynamic range, reproduction of the complete audible spectrum, and maintenance of adequate separation for good stereo reproduction. These requirements must be fulfilled with a minimum of distortion, while at the same time providing a maximum of record and tip life.

As stringent as the requirements of playing back the modulation are, consideration must also be given to the practical conditions that exist in the normal, non-laboratory situation. We have described a phonograph cartridge system which offers a means of controlling the most significant practical problems, namely: 1) undamped low-frequency resonance excited by record warp and structure-borne noise, 2) the effects of electrostatic charges, and 3) dust and dirt on the record surface.

Extensive testing has shown that control of these conditions provides a significant improvement in phonograph reproduction. ∆

The disco boom that erupted across the U.S. in the middle of 1975 not only shows no signs of abating as far as new clubs in new areas are concerned, but now has been crossing over from the mobile operation into the home.

As a result, more companies—both traditional hi-fi and audiophile firms, sound reinforcement veterans, and the newer breed of custom disco sound manufacturers—are designing a wider range of products designed to fit all budgets and all "environmental" situations that might arise.

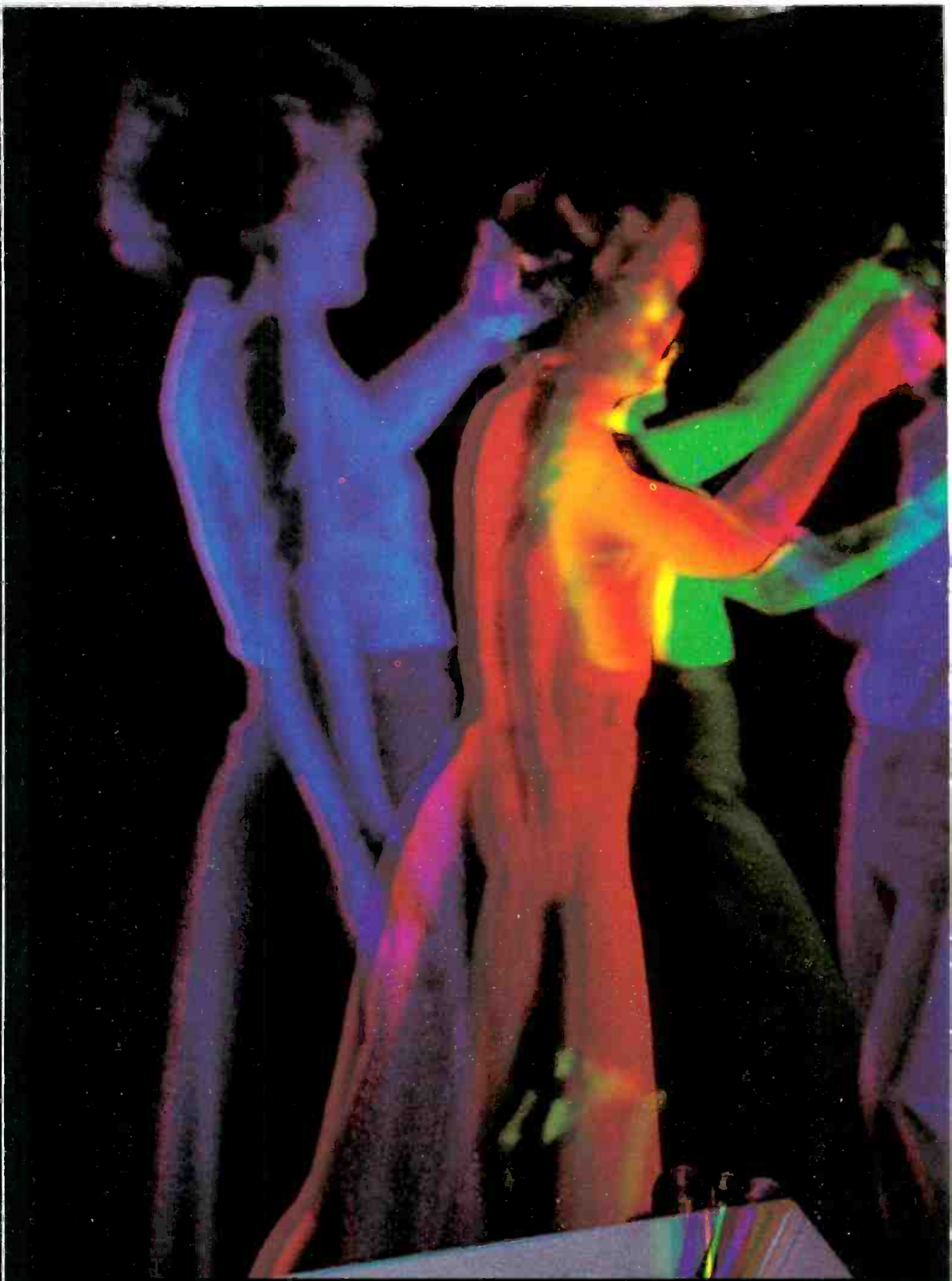
On the retail scene, a growing number of chains are adding "disco corners" to demonstrate the expanding array of equipment being offered, and those that got in on the ground floor—like Harvey Sound in New York—are rapidly establishing themselves as a full-service location for both the professional disco operator and the growing number of consumer "discophiles."

The discophile has a wide range of product brands from which to choose, for as club respondents to *Billboard* magazine's second industry-wide brand-usage survey this year indicated, with the exceptions of Technics for turntables, Shure for microphones, and Stanton for cartridges, no equipment category is dominated by any one company.

What the buyer has to be wary of are the equipment specs. The industry is littered with a number of casualties from both the traditional audio field—those who tried to pass off consumer units for the heavy-use disco operation—and the new custom manufacturer, who came in for the "fast buck" and wound up empty, along with a number of gullible customers.

Disco components are designed for hard punishment—power amps and speakers built for high decibel output; turntables with fast start-up, good isolation, and minimal feedback; low-mass cartridges able to take back cueing; versatile mixer/preamps geared to handle a variety of phone and tape inputs, plus fading, cueing, and monitor functions, and equalizers that are becoming vital in both the program and room areas.

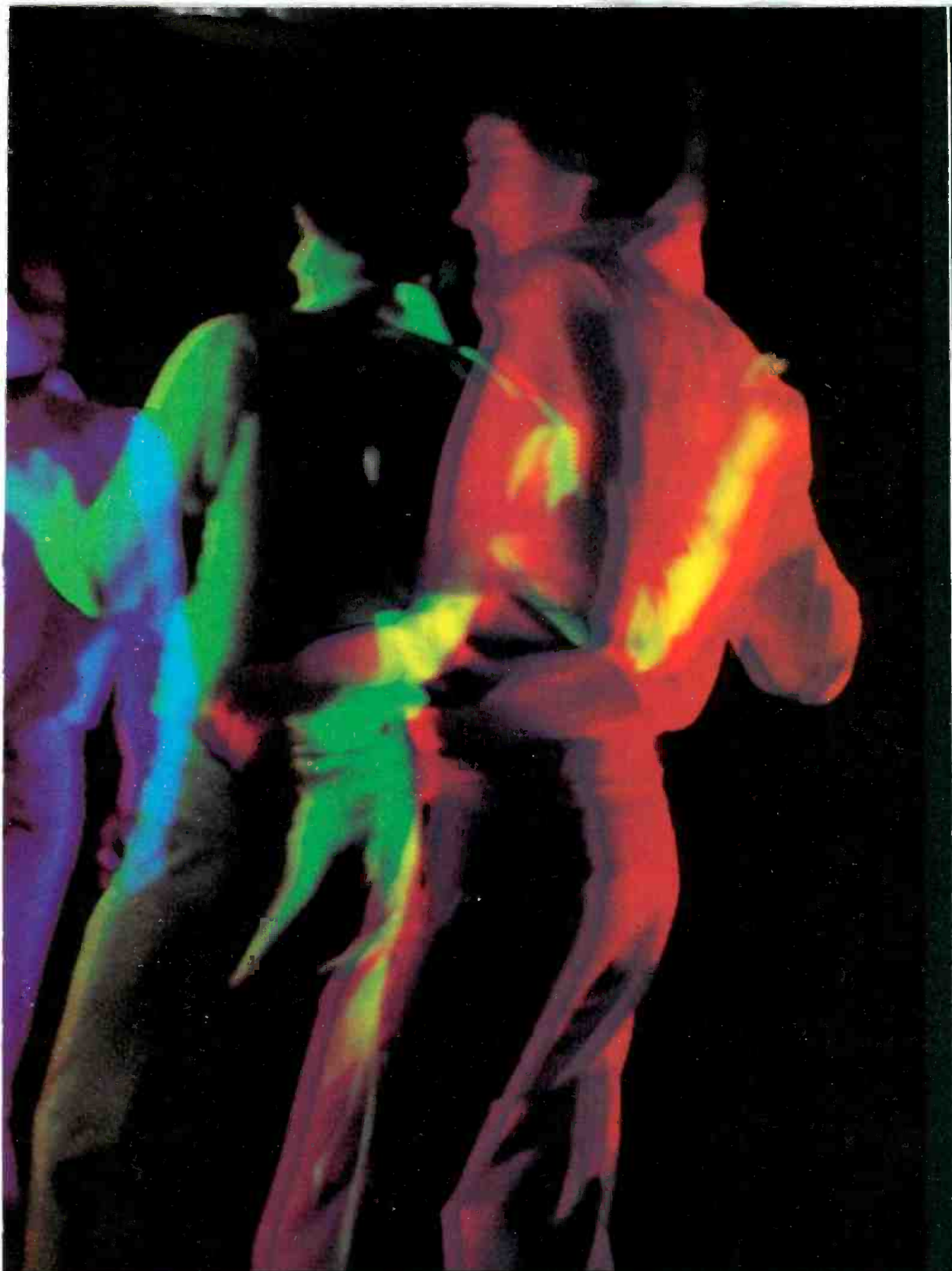
As the *Billboard* disco equipment usage survey indicates, the emergence of the sound specialist has led to the growth of custom suppliers and packagers, who now are competing in the marketplace with more traditional audio firms in offering custom-built mixers and preamps, as well as bastardized speaker systems with efficient crossover networks using the best high-power-capacity components available from all sources.



DISCO

The result is that designers and packagers—and the emerging discophile—more often than not are "mixing and matching" in their components based on the needs of their particular operation or home situation, rather than simply choosing the most "popular" brand. This key factor should be kept in mind when checking the survey results below.

In addition to Technics for turntables, Shure for microphones, and Stanton for cartridges, other category leaders include Meteor Light & Sound, mixers; JBL, speakers (including components); BGW, power amplifiers; Bo-



SCENE '78

Stephen Traiman

zak, preamps; Soundcraftsman, equalizers; TEAC, tape decks, and Koss, headphones.

Survey respondents by percentage, for each type of equipment are:

Turntables—Technics, 62%; Russco, 8%; QRK (transcription), 7%; Pioneer, 5%, and others, 18%, including BSR, Garrard, Gates, JVC, Kenwood, Marantz, Sparta, and Thorens. (Thorens had a much larger initial share of the market with its TD-124 unit, which it then discontinued despite protests from its U.S. distributor. Technics, in contrast, continues to expand its "disco" line with obvious results.)

Power amps—BGW, 17%; Crown, 15%; McIntosh and Phase Linear, each 11%; Cerwin-Vega and Dynaco, each 8%; SAE, 4%; Peavey, 3%, and others, 23%, including Altec, Bose, Erath, Harman Kardon, Heathkit, Pioneer, Sansui, and Yamaha. (This is the "closest" category as many firms are offering high-power units—150 watts rms/channel and up—with overload circuitry.)

Mixers—Meteor, 20%; Bozak, 15%; Cerwin-Vega, 13%; GLI, 12%; Showco and Sony, 6% each, and others, 29%, including Disco Scene, Erath, Peavey, Russco, Sparta, TEAC, and Yamaha. (Another close grouping, where crossover professional units are competing with the newer custom-tailored models for disco operations.)

Speakers—JBL, 33%; Altec, 17%; Cerwin-Vega, 16%, Bose, 7%, GLI, 4%, and others, 24%, including B•I•C Venturi, Electro-Voice, Erath, Klipsch, Peavey, and Yamaha. (JBL in particular, and Altec as well, get as many mentions for providing key components such as drivers and tweeter arrays to many custom manufacturers.)

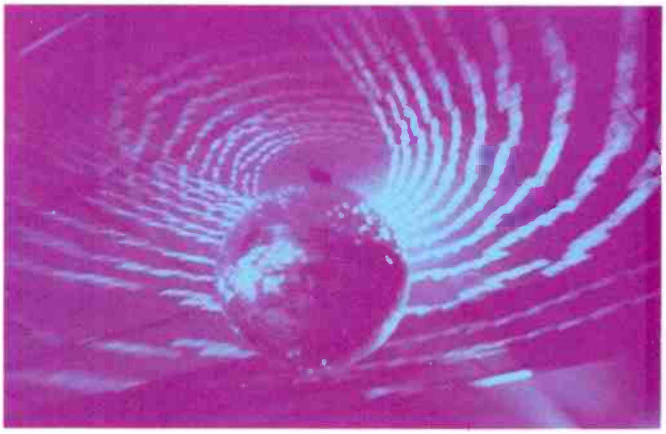
Preamps—Bozak, 13%; Crown, 12%; GLI, 9%; McIntosh, 8%; Cerwin-Vega, 6%, Dynaco and SAE, each 5%; Marantz, Shure and Phase Linear, each 4%, and others, 26%, including Altec, Erath, JVC, Harman Kardon, Peavey, Pioneer, Realistic, Soundcraftsman, and URE. (Some overlap here with mixers, as a growing number of units are combination mixer/preamps.)

Equalizers—Soundcraftsman, 27%; SAE, 15%; Tapco, 11%; Spectro Acoustics, 6%; Cerwin-Vega and JVC, each 5%, and others, 31%, including Bose, BSR/ADC, Crown, Dynaco, MXR, Pioneer, Realistic, and Shure. (Probably the fastest expanding component category, as the equalizer has rapidly become one of the more important "environmental" factors in the club, mobile operation, and the home.)

Tape decks—TEAC, 39%, Sony, 17%; Akai, 14%; Pioneer, 7%; Panasonic, 6%, and others, 17%, including Dokorder, Revox, and Nakamichi. (Also a growing category, as more clubs and discophiles are using the alternate tape source along with their twin turntables.)

Phono cartridges—Stanton, 51%; Shure, 33%, and others, 16%, including AKG, Audio-Technica, Empire, and Pickering. (Another good example of how a traditional hi-fi company, Stanton, tailored a product to the market—the 681EEE cartridge—and wound up with a significant share.)

Microphones—Shure, 61%; AKG, 12%; Electro-Voice, 7%; Sony, 4%, and others, 16%, including Beyer Dynamic, Sennheiser, and Unisphere. (A further example of how a veteran audio firm, Shure Bros., came up with a series of mikes geared to disco applications, among other versatile uses, and seized a lion's share of the market.)



Headphones—Koss, 35%; Sennheiser, 19%; Pioneer, 15%; Realistic, 7%; AKG, 5%, and others, 19%, including Audio-Technica, Beyer, Le-Bo, Panasonic, Spectrum, and Stanton.

The one key area not covered in the survey, and of particular interest to the discophile, is the mobile console that is perhaps the fastest growing category of equipment. As some areas have become overpopulated with clubs, the expansion of the mobile disco disc jockey has been nothing short of remarkable. It is virtually impossible to find any area of the country that doesn't have one or more enterprising entrepreneurs ready at a moment's notice to bring his portable equipment array to an event or location, be it large or small.

This same equipment is also finding favor with the expanding cult of discophiles, as it is generally packaged more attractively and economically, incorporating all the key components necessary for generally acceptable sound enhancement.

Among portable suppliers are Meteor Light & Sound, Audio Transport Systems, and Musical Instrument Corp. of America here, and a growing number of import lines that include Citronic, Futuristic Aids Ltd. (FAL), and Soundout Labs, all from Britain.

Meteor Light & Sound brought its disco know-how across the Atlantic from England, and this growing subsidiary of Hammond Industries was one of the first to offer a portable disco console, either equipped with its own components or "equippable" with any other company's. It features a fold-away design into a transportable 18- by 52- by 21-inch container, and becomes a full-height, floor-mounted control console when set up. The unit can be purchased with any of Meteor's Clubman mixer/preamps, new power amplifiers, Beyer microphones (Hammond is the U.S. distributor), turntables, and headphones of choice.

Audio Transport Systems is another one of the new breed of custom equipment firms that has tailored a line to the disco market. The portable system, previewed at Disco I and shown at both the Consumer Electronic Shows, along with the Audio Engineering Society displays, offers twin Russco or Technics turntables, along with the ATS DC-202 preamp/mixer and any one of its three speaker systems.

One of the new entries in the portable area on a more economical level is the line of mixing consoles debuted at *Billboard's* 1977 Disco III show and seminars in New York by the LaTec International division of Musical Instrument Corp. of America. Ranging from $349.00 to $849.00, the three models offer a variety of features up to their top-of-the-line auto-fade system that allows "hands free" operation of the microphone without touching sound levels.

Soundout Laboratories of England was one of three British firms debuting their portable lines in the U.S. at *Billboard's* Disco III. The series of mono and stereo consoles is topped by the Stereo VII with a reinforced Fiberglas cabinet design, offered with or without two built-in, 200-watt power amps. The U.S. distributor is Lights Fantastic.

Another English firm lining up a U.S. distributor is Futuristic Aids Ltd. (FAL), which has Capitol Stage Lighting handling its line of portable consoles

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"The Model E-50 (is) exceptionally clean and easy-to-listen-to.... The woofer's response, from 50 to 300Hz, was exceptionally flat.... The high efficiency ... was dramatically illustrated by the Model E-50's ability to deliver a 95-dB SPL at 1 meter when driven by 1 watt of random noise in the octave centered at 1000Hz.... It can produce prodigious levels of very clean sound...."**

Write to us for the name of your nearest Wharfedale dealer and ask for full product and technical literature on the E-70's and E-50's. Then listen to the dynamic new sound of Wharfedale.

Excerpted from Julian Hirsch's (Hirsch-Houck Labs.) test reports on the E-70 in Stereo Review, May '78* and on the E-50 in Popular Electronics, April '78** © Ziff-Davis Publishing Co.

matched walnut veneer enclosures.

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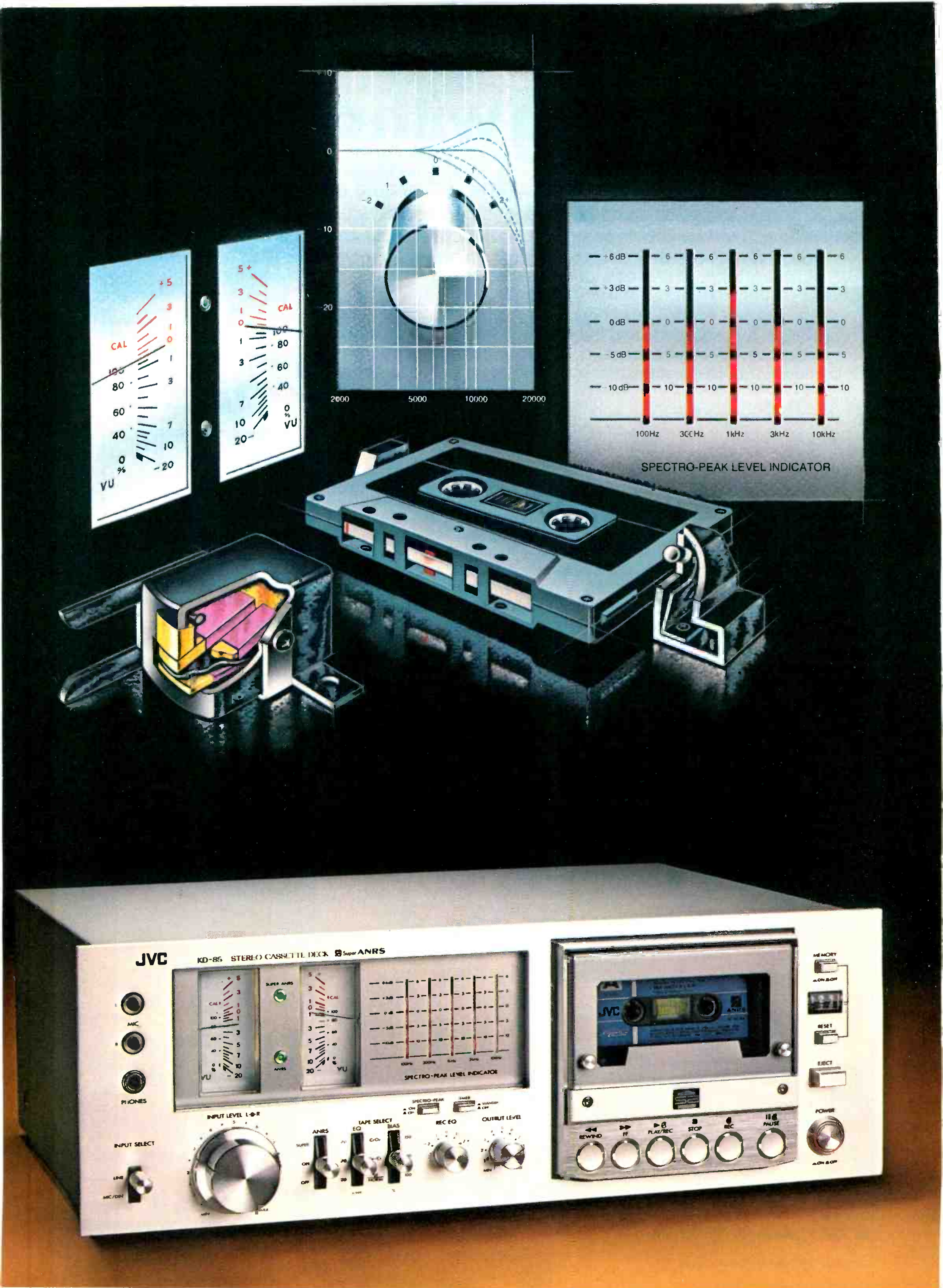
RANK HIFI Inc., 20 Bushes Lane, Elmwood Park, New Jersey 07407 (201) 791-7888


CAL
VU
+6 dB
+3 dB
0 dB
-5 dB
-10 dB
100Hz
300Hz
1kHz
3kHz
10kHz
SPECTRO-PEAK LEVEL INDICATOR
2000
5000
10000
20000
JVC
KD-85 STEREO CASSETTE DECK Super ANRS
MIC
PHONES
INPUT SELECT
INPUT LEVEL L·R
ANRS
TAPE SELECT
EQ
BIAS
REC EQ
OUTPUT LEVEL
REWIND
FF
PLAY/REC
STOP
REC
PAUSE
MEMORY
RESET
EJECT
POWER

THE JVC CASSETTE DECK.

It gives you more of what other decks wish they could.

Some day there'll be totally automatic, absolutely foolproof, distortion-free cassette deck recording. And when it happens, JVC will develop the technology to achieve it. But until then we've come mighty close to it. Our new collection of quality cassette decks embodies exclusive and advanced features that thoroughly reinforce our reputation for innovative thinking.

EXCLUSIVE SPECTRO PEAK INDICATOR SYSTEM

The new KD-85 and KD-65, for example, offer more positive recording control than ever before. The reason is the newly developed and exclusive JVC Spectro Peak Indicator system. With almost recording studio vigilance, 25 instant-responding LED indicators offer you fail-safe protection against distortion produced by tape over-saturation. For the first time, you can constantly visually monitor the levels of five low-to-high frequency ranges. Then, on playback, the Spectro Peak Indicator display lets you actually see how successfully you reproduced the music.

EXPANDED DYNAMIC RANGE AND BETTER NOISE REDUCTION

If you've ever had difficulty recording without distortion the sudden high peaks of a piercing jazz trumpet or the head-snapping clash of cymbals, you'll appreciate the value of our Super ANRS. Developed exclusively by JVC, it applies compression in recording and expansion in playback to improve dynamic range at high frequencies. But it doesn't stop there. Super ANRS is a highly effective noise reduction system that reduces tape hiss by boosting the signal-to-noise ratio as much as 10dB over 5,000Hz.

NEW HEAD DESIGN

Most other makes of cassette decks opt for either permalloy or ferrite tape heads. JVC gives you the best of each with our own Sen-Alloy head. It combines the sensitive performance of permalloy with the extreme longevity of ferrite.

GET THE MOST OUT OF ANY TAPE

JVC also gives you freedom of choice in the tape you use. Because whichever type you select, you'll extract the most performance from it with our matchless recording equalizer circuit.* This unique JVC feature lets you fine tune different combinations to get optimum high level response from any tape on the market.

These innovations alone set JVC cassette decks apart from all others. Then, when you consider our other refinements like the precision ground capstan, independent drive mechanism,* or our gear/oil damped cassette door, plus top-performance specifications, you can understand why JVC gives you more of what other decks wish they could.

JVC America Company, Div. of US JVC Corp., 58-75 Queens Midtown Expressway, Maspeth, N.Y. 11378. Canada: JVC Electronics of Canada, Ltd., Ont.

JVC

We build in what the others leave out.

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KD-85 (featured at left); Below: KD-65, KD-55 & KD-25 (top row); KD-10, KD-1770II & KD-1636II (bottom row). Not shown: KD-2, KD-2020, KD-3030 & KD-S201.

*Not all features in all models.

Record Jacket Art Books Compared

1. Technical Data

Title	Album Cover Album	Phonographics
Publisher	Dragon's World/ A&W Visual Library	Collier Books (Paperback)
Editors	Roger Dean/ Storm Thorgerson (Hipgnosis)	Brad Benedict/ Linda Barton
Designer	Uncredited	Rod Dyer
Text	Dominy Hamilton, et al.	Charles Perry/ Peter Plagens
Dimensions	12"X12"X$\frac{7}{16}$"	9"X12"X$\frac{11}{32}$"
Pages	160	142
Illustrations	681 covers	133 covers
List Price	$10.95	$9.95

James Wizard Wilson

Phonographics and *Album Cover Album* are examples of the "New Wave" of picture books pioneered by *The English Sunrise*. These books go beyond earlier soft-cover color picture collections, especially *Album Cover Album* which almost establishes a whole new category. In addition to its hundreds of captioned illustrations and a nice amount of useful text in appropriate places, it adds a very cinematic approach to its image editing and a pleasant attention to graphic detail. Its best description is "book as toy." The following tests and comparisons reveal the similarities and differences between two books which are ostensibly concerned with the same subject.

Graphics by Wizard Studios
Computers by 2005 A.D.

Editorial Comparisons

These books form a rather remarkable dichotomy. *Phonographics* is very heavily oriented toward album art of the California airbrush-surrealist style, while the *Album Cover Album* leans toward the photo-mannerist school of album art as practiced by Hipgnosis. These biases are responsible for the books' being referred to in the art biz as "the Dave Willardson book," after *Phonographics'* cover artist and most prolific contributor, and "the Hipgnosis book," for the same reason.

2. Formats & Frequency

An inspection of the picture formats used in these books and a tabulation of the number of times they occur in each book (frequency) reveal the reason for the great disparity in the total number of illustrations per book. Frequency is the number beneath each format photograph. Calculation discloses that 91 per cent of *Phonographics'* covers are full-page or larger, while 79 per cent of *Album Cover Album's* are four, or more, to the page.

The photographs also show the greatest similarity between the books; virtually identical picture grids within otherwise dissimilar page formats. It is interesting to note that even with poor image quality and the tiny (2-in. square) size of jackets on 16-panel grid pages, they still look good. This is a tribute to the power of good album graphics.

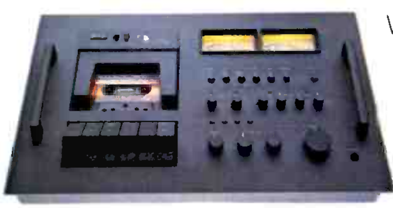
It's a bird! It's a plane! No, it's the Nakamichi 600 II.

The new 600 II Cassette Console does not leap over tall buildings in a single bound. It has no flashing lights. It doesn't have a built-in computer, and it won't make coffee for you in the morning.

But the 600 II does one thing better than any other cassette deck in its class: make recordings that are indistinguishable from the original.

Beneath its functionally elegant, sloped panel lies some of the most sophisticated engineering in the world. Thanks to Nakamichi's latest achievement in magnetic technology, the incredible SuperHead, the 600 II sets new standards for two-head cassette deck performance, with a guaranteed minimum frequency response of 35-20,000 Hz ± 3dB.

These days, you can buy a three-head cassette deck for about half the price of the 600 II. But anything less than Nakamichi, regardless of the number of heads, motors, etc., would mean a compromise in sound quality.



Write for more information:
220 Westbury Avenue,
Carle Place, New York 11514.

Nakamichi

Products of unusual creativity and competence...

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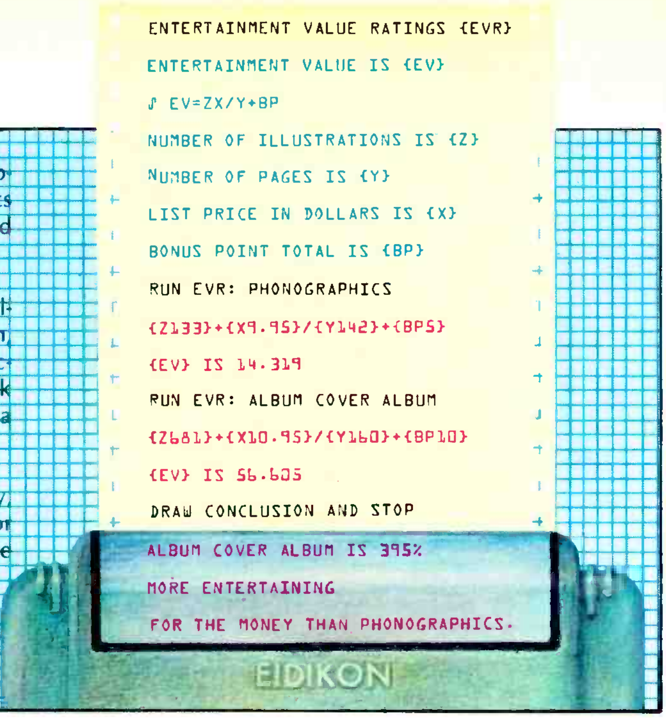
3. Entertainment Value

Since these are both "picture books," text other than captions is not of vital importance. We did award Bonus Points for extra entertainment, mostly based on introductions and other text.

Album Cover Album was awarded 10 points for its well-researched Art History 101-style intro by Dominy Hamilton, its tour guide-style notes at the beginning of individual sections and the informative material in the back of the book which details "The Role of the Art Director," "Designing a Record Cover," and "The Printing of Record Covers."

Phonographics was given five Bonus Points for its breezy, mostly well-informed introduction by *Rolling Stone* Editor Charles Perry, with Artist-Author Peter Plagens. Once the reader overcomes the near-unreadable typographic design, he will find a pleasant, irreverent look at the subject, more fun than the pseudo-ecclesiastical tone of *Album Cover Album's* introduction.



As a result of this polarity, there is very little overlap of content between the books. This sort of picky examination of books tends to exaggerate the importance of details, so occasionally the lack of overlap appeared almost suspicious. For instance, Hipgnosis' lovely cheesecake cover for The Pretty Things' *Silk Torpedo* occupies two pages in *Phonographics,* while not even appearing in their own, so to speak, book.

The books are also different in their aspirations. *Album Cover Album* sets out to cover the whole history of the medium, with roughly half the book devoted to covers from the past 10 years. *Phonographics* is *only* concerned with the past 10 years' crop of jackets, and within that category it's mostly (and unabashedly) concerned with the product of the American West Coast. An analog as college courses would have *Album Cover Album* entitled "A Survey of Record Jacket Art" while *Phonographics* would be billed "California-style Album Graphics, 1967-77."

As to quality of selection, both books have their quirks. *Album Cover Album's* is that many inclusions were made seemingly because they fit into a particular category, with no evident concern for their normal standards of selection. This must be considered a quibble, though, in light of the number of jackets in the book and its history-text approach to the subject.

Phonographics is not so easily excused for its quibble: The inclusion of much early unpublished (read unsold) album-style art by various heavy contributors to the book. With the possible exception of an early piece by the brilliant Mick Haggerty, the stuff is a waste of valuable color pages. Even the Haggerty is useful chiefly to indicate degree of improvement.

Graphics and Design

First of all, *Album Cover Album's* record jacket-shaped and sized format is so appropriate to its subject matter that *Phonographics* use of the more common 3x4 proportion seems like a matter of expediency rather than taste. It would probably never occur to a *Phonographics* purchaser to keep it next to his audio system with the records, but that's where the *Album Cover Album* nearly always ends up. Its heavier cover gives it the same rigidity as an album, so it leans nicely against a speaker enclosure. Thus, it tends to get used more because it's out in the open, rather than enshelved with the other books.

The cover graphics of both books strongly reflect their respective editorial styles and orientations. *Phonographics* shows its California origins and West Coast outlook with its splashy title rendition sloshing in deft mustard abandon across a bloated airbrush caricature of a paintbrush, which assumes the role of tonearm to a record disc beneath. However, the wasp-like tip of the brush isn't playing the record, it's depositing a thin trail of the amber title ooze onto the grooves. The image projected by this illustration probably does for serious audiophiles what Neon Park's *Weasels Ripped My Flesh* cover does for people with toothbrush-into-razor nightmares. Yeeow!

There are no specific credits furnished for *Album Cover Album's* cover, but one can safely assume that the typography and lettering are by Roger Dean, artist-publisher, one of the book's editors. The photo-collage illustration is surely by Hipgnosis. It has been souped-up and worked nearly to the point of death. In order to achieve the ultra-violent blue of the sky and the fingernail red of the T-Bird hood in the foreground, the red, blue, and yellow dots which compose the image are so cranked up that in areas where there are dots of all the colors, such as in the green grass, the color saturation shifts greens into muddy browns. The resulting blasted-heath effect detracts from the otherwise "classy" packaging of the book.

Interior Design

Although the test volumes have different dimensions, comparison measurement reveals that their picture grids are virtually identical in size (8¼ in. square). This similarity of grids and how the page designs are affected is graphically displayed in the "Formats & Frequency" box. As may be seen, the *Album Cover Album* grid is surrounded by wide margins, while *Phonographic's* grid is stuffed into a narrower page with almost vestigial ¼-in. top and side margins. This layout tightness *does* add a sort of dynamism to the viewing process. Forced into this proximity, illustrations tend to either fight to the death or take on whole new personalities. Many jackets appear to be wrap-arounds, whether they began that way or not.

Album Cover Album's more open page design is further enhanced by the light, neutral-color tones surrounding its picture areas. This little detail, while probably not costly, really improves viewing. It totally conceals the paper beneath,

Music you never knew was there.

There are probably beautiful musical passages on many of your records that you've never heard. And you never will, unless your cartridge is sensitive enough to clearly reveal all the subtle harmonics within the audio spectrum.

Today's sophisticated "direct to disc" technology has raised the quality of disc recording to a new state of the art. You need a cartridge that does justice to these fine recordings: an ADC cartridge. With an ADC cartridge, you will find the state of the art has been brought almost to the state of perfection.

Long known by audiophiles for incredibly pure sound reproduction, ADC cartridges have also proven their amazingly low record wear. This year, they have even surpassed themselves.

First, there's the remarkable new ZLM with the unique ALLIPTIC™ stylus. It combines the better stereo reproduction of the elliptical stylus shape with the longer, lower wearing, vertical bearing radius of the Shibata shape. As a result, sound reproduction is completely transparent and clean. Individual instrument placement is more easily identifiable. And frequency response is ruler flat ±1dB to 20kHz and ±1½dB to 26 kHz. It tracks at ½ to 1¼ grams.

Then there's the new XLM MK III with the same reduced mass, tapered cantilever but with a true elliptical shaped nude diamond tip. It has 50% lower mass than our previously lowest mass XLM MK II. It tracks at ¾–1½ grams.

The QLM 36 MK III with the innovative Diasa elliptical nude tip also has excellent frequency response, wide separation and an incredibly clean sound. It also tracks at ¾–1½ grams.

The QLM 34 MK III offers elliptical shape and tracks as low as 1 gram with flat response out to 20kHz ±2dB.

The QLM 32 MK III is a 2–4 gram elliptical with great sound. It's one of the best budget ellipticals around.

And ideal for automatic changers, the QLM 30 MK III is a 3–5 gram conical stylus that's compatible with a wide range of stereo equipment.

The ADC cartridges. Think about it. You probably don't even know what you're missing.

ADC

A BSR Company

Audio Dynamics Corporation
Pickett District Road
New Milford, Conn. 06776

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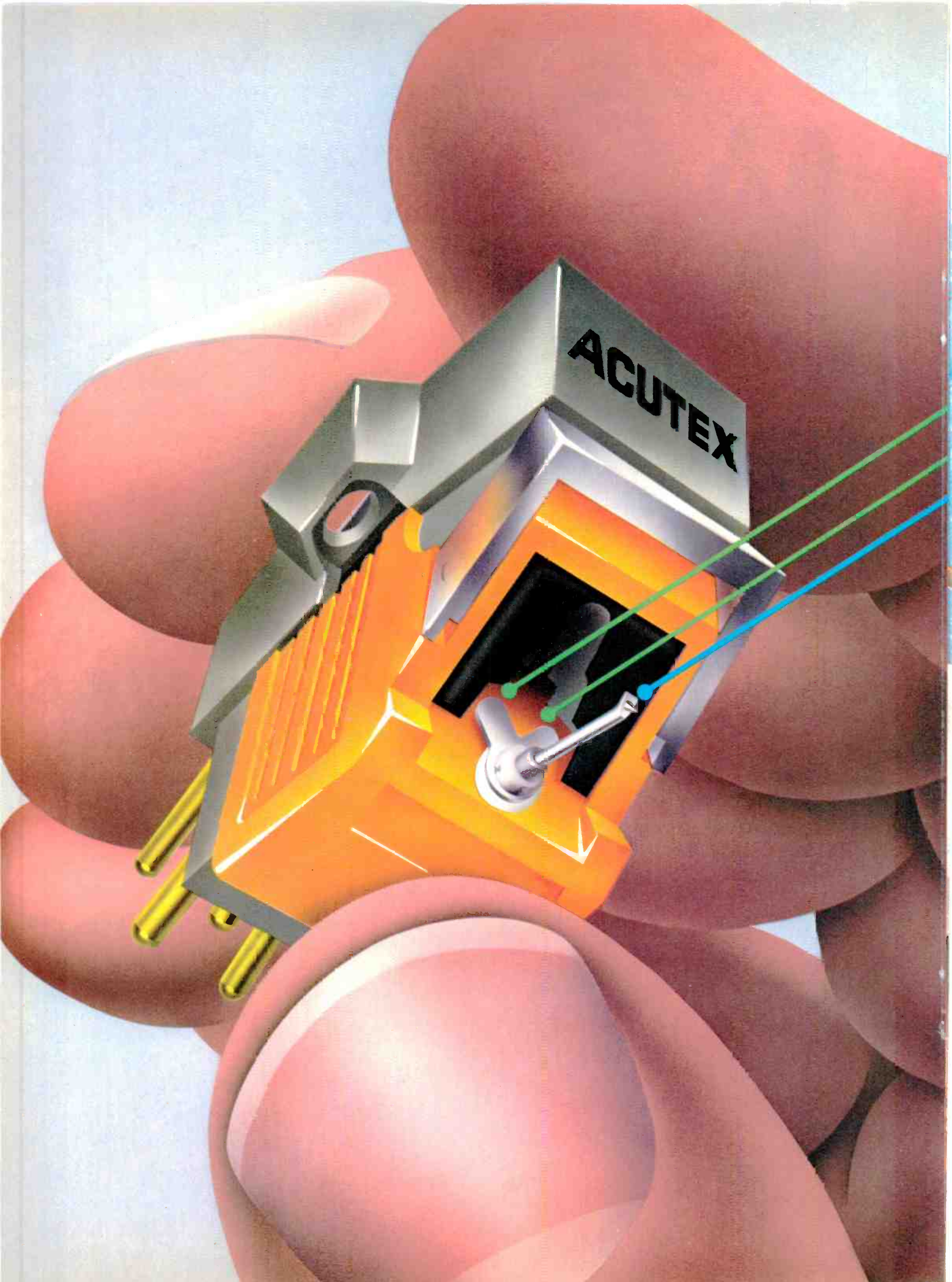
ACUTEX

CREATING THE WORLD'S BEST STEREO SEPARATION WAS AS EASY AS X,Y,Z.

If you were asked to describe the performance of your stereo system, you'd rattle off the typical statistics.

Watts per channel. Woofer size. And of course, frequency response.

But chances are, you'd be hard pressed to say how much your cartridge separates the left channel from the right. Yet, of all stereo specifications, none is a better judge of how well your system reproduces music than stereo separation. Because the greater its separation, the more three dimensional your music sounds.

Unfortunately, while other components have improved dramatically every year, cartridges have remained basically the same for twenty. Until now.

AN ACUTEX CARTRIDGE DOESN'T GET ITS SIGNALS CROSSED.

To understand how unique an ACUTEX cartridge is, you have to know something about the common cartridge.

There are two major principles used to convert a record's grooves into electricity. Moving Iron and Moving Magnet.

With the first, the stylus arm, or "cantilever," is made of iron and wiggles near a coil and magnet inside the cartridge. In the second, a tiny magnet attached to the cantilever wiggles near those coils.

Both have drawbacks. A moving iron is a much weaker generator of electricity than a moving magnet. But a moving magnet is much heavier. Its increased weight can wear out your records faster, and might destroy certain high frequency passages at first playing.

Even worse, stereo separation is only fair in either case. Because one iron or one magnet is the source for two channels. But five years ago, some inventor had a brainstorm.

Instead of a single magnet attached to the cantilever, he used two. One for the left (X) and one for the right (Y).

Instantly, the cartridge's output rose and stereo separation improved.

It was good, but not good enough.

Since it was heavier. And when (X) wiggled it also caused (Y) to wiggle slightly; causing some left channel signals in the right channel.

There was no barrier to stop that cross talk, and stereo separation suffered.

ACUTEX created the barrier. With basic geometry.

OUR BOTTOM-OF-THE-LINE BEATS THEIR TOP-OF-THE-LINE.

First, we increased output even further by making the cantilever itself magnetic (Z). Thus we had three moving magnets at 90-degree angles to each other; each in a separate plane in relation to the coils.

So when a record played, (Z) canceled out any spurious signals created in the left channel by the right.

And vice versa.

Finally, because we placed one powerful magnet inside the cartridge—*inducing* the magnetism into our three lightweight armatures—the weight was sharply reduced.

The result was stereo separation so great that our $35 model rivals many of our competitors' $135 models.

And the two best ACUTEX cartridges *surpass* the separation specs all record companies use when cutting an album!

ACUTEX 320
Response: 20-45,000 Hz
Compliance: 42 x 10^{-6} cm/dyne
Separation: 32 db (1 kHz), 29 db (10 kHz)
Suggested List Price: $175.00

ACUTEX 315
Response: 20-31,000 Hz
Compliance: 36 x 10^{-6} cm/dyne
Separation: 30 db (1 kHz), 28 db (10 kHz)
Suggested List Price: $135.00

ACUTEX 312
Response: 20-29,000 Hz
Compliance: 24 x 10^{-6} cm/dyne
Separation: 30 db (1 kHz), 27 db (10 kHz)
Suggested List Price: $85.00

ACUTEX 310
Response: 20-25,000 Hz
Compliance: 16 x 10^{-6} cm/dyne
Separation: 28 db (1 kHz), 25 db (10 kHz)
Suggested List Price: $65.00

ACUTEX 307
Response: 20-20,000 Hz
Compliance: 14 x 10^{-6} cm/dyne
Separation: 25 db (1 kHz), 23 db (10 kHz)
Suggested List Price: $45.00

ACUTEX 306
Response: 20-20,000 Hz
Compliance: 14 x 10^{-6} cm/dyne
Separation: 25 db (1 kHz), 20 db (10 kHz)
Suggested List Price: $35.00

DIAMONDS, GOLD, AND PRECIOUS RECORDS.

Not only will ACUTEX deliver outstanding separation of your music, you'll hear more music to begin with.

Because ACUTEX's three armatures decrease record surface noise at the same moment they increase record signals. Soft notes especially sound clearer, with minimal snap, crackle, and pop.

Each ACUTEX cartridge was designed with a diamond stylus best suited for its purpose.

Our 315 model has a solid (nude) elliptical diamond with a frequency response through 31,000 Hertz.

And the 320 provides a ruler-flat response up to 45,000 Hertz, using a recently developed STR (Symmetrical Tri-Radial) diamond.

On all ACUTEX models, the terminal pins are gold-plated. This allows for maximum electrical contact to your other stereo components.

Since we applied the principle of induced magnetism, ACUTEX has a very low Effective Tip Mass. Which means our cartridges are extremely gentle on groove walls, so you can play your oldest and most precious albums without permanent damage.

But frankly, all our words and pictures won't convince you half as much as your ears. One listen, and you'll be convinced that until now, stereo sound this good was truly unheard of.

ACUTEX will be coming soon to selected hi-fi stores in your area.

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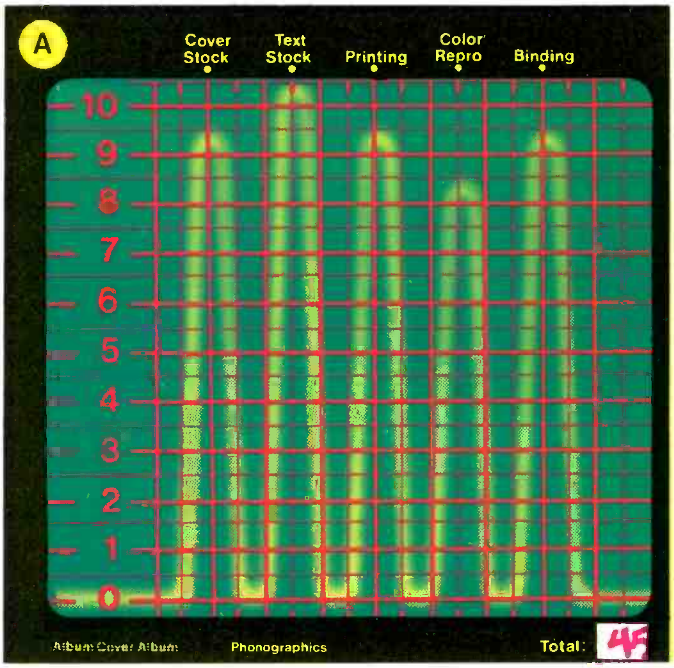
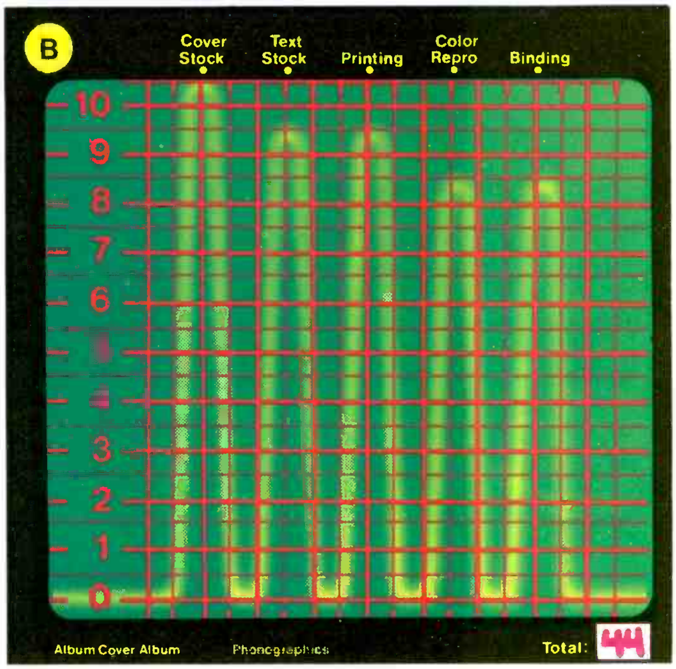
4. Quality Factors





Ratings and totals on this test imply that *Phonographics,* although not as highly detailed as *Album Cover Album,* is actually of slightly higher quality, with greater durability. Four-week bookbag stress testing verified this thesis; at the termination of testing *Phonographics* was still intact and presentable while the *Album Cover Album* was frayed, and its binding had begun to disintegrate.

which is actually cheaper than *Phonographics'* really expensive stock.

The inks used to print the interior of *Album Cover Album* are cleverly formulated to add to its glamour. The red, blue, and yellow inks are matte-drying, while the black ink dries glossy. As black is only used in illustrations or type, and every page is covered by matte color tones, pictures stand out from their backgrounds like decals. Yum-yum!

Quality Factors

The quality of materials and workmanship in a book determines its durability and also affects its appearance. Reproduction and printing quality determine the fidelity of its images and the legibility of its text. In rating quality factors, the books were scored on a 1-to-10 scale for each of five factors. The total points give a comparison score which is reasonably accurate.

The *Phonographics* liquid-laminated 12-point cover, while as good or better than other trade paperbacks, is overshadowed by the splendor of *Album Cover Album's* jacket. It's twice as thick and clad in a super-glossy, film-laminate coating. The effect is rather like a resilient piece of Formica countertopping, or the hood of a Corvette.

Phonographics' text stock, a beautiful matte-finish coated paper, edges out *Album Cover Album's* lesser stock. To be honest, the difference hardly matters, since almost no virgin paper surface shows in the *Album Cover Album* anyway. The book's ubiquitous color tints and other production tricks give an impression of high quality which the more workmanlike *Phonographics* lacks, but printing quality in both books is actually of mediocre level.

Color reproduction in both books ranges from excellent to awful, seemingly dependent upon size of illustration and the method used to color-separate the color images. Most pictures in the books are taken from color transparencies of the original jackets, rather than from the jackets themselves. Although cheaper to produce because of convenience and automation, this type of separation tends toward a muddiness of imagery without extra dot etching, which costs more. I found no evidence of dot-etching in the smaller images of either book.

Album Cover Album has a sewn-and-glued hybrid binding that seems a little flimsy for a book of its size. *Phonographics'* binding is sturdier, but the copy I bought was marred by excessive adhesive on the inside of the cover.

The full-page bleed images in *Album Cover Album* are far superior to those of any other picture formats in either book. My explanation for the phenomenon is that images on bleed pages are taken from the original production negatives of the jackets on those pages. Murkiness and lint infest the nine- and sixteen-panel pages in *Album Cover Album* and the four-panel pages in *Phonographics.* It would appear that image quality was considered unimportant in the smaller illustrations of both books.

Conclusion

It is indeed unfortunate for *Phonographics* that it was released at the same time as the *Album Cover Album* because it's sure to suffer most in competition for the buyer's dollars. It would have done much better a year earlier, since it's basically a nice book when considered on its own merits. *Album Cover Album,* with its larger size, lavish detailing and wealth of imagery is sure to be a hit, even at its $10.95 list price. More books like this one could kill off television.

Graphic artists, pop cognoscinti, and interested audiophiles should consider buying both volumes, as they work together nicely as a set, with *Phonographics* perceived as an amplified appendage to *Album Cover Album.*

Only one direct-drive semi-automatic has a concrete advantage.

If you want the precision speed control of direct drive and the convenience of a turntable that shuts itself off, you can choose from many brands.

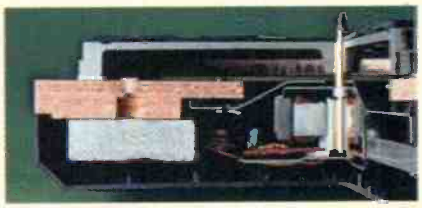
But only the Kenwood KD-3070 has a solid advantage that can really make a difference.

Because the turntable base is made with dense resin concrete, it virtually eliminates acoustic feedback.

That means that no matter how loud you play your music, the vibration in the air won't couple vibrations to the tonearm and cause howl.

In fact, while we don't recommend it, you can actually place this turntable on top of a speaker and crank up your volume without causing feedback.

The same thought that goes into creating our resin concrete base goes into the design of our tonearm and turntable controls as well.



Dense resin concrete in base virtually eliminates vibration.

And if that's not enough to convince you, consider this: You can buy the KD-3070 for less than $175.00.*

That's a concrete advantage, too.

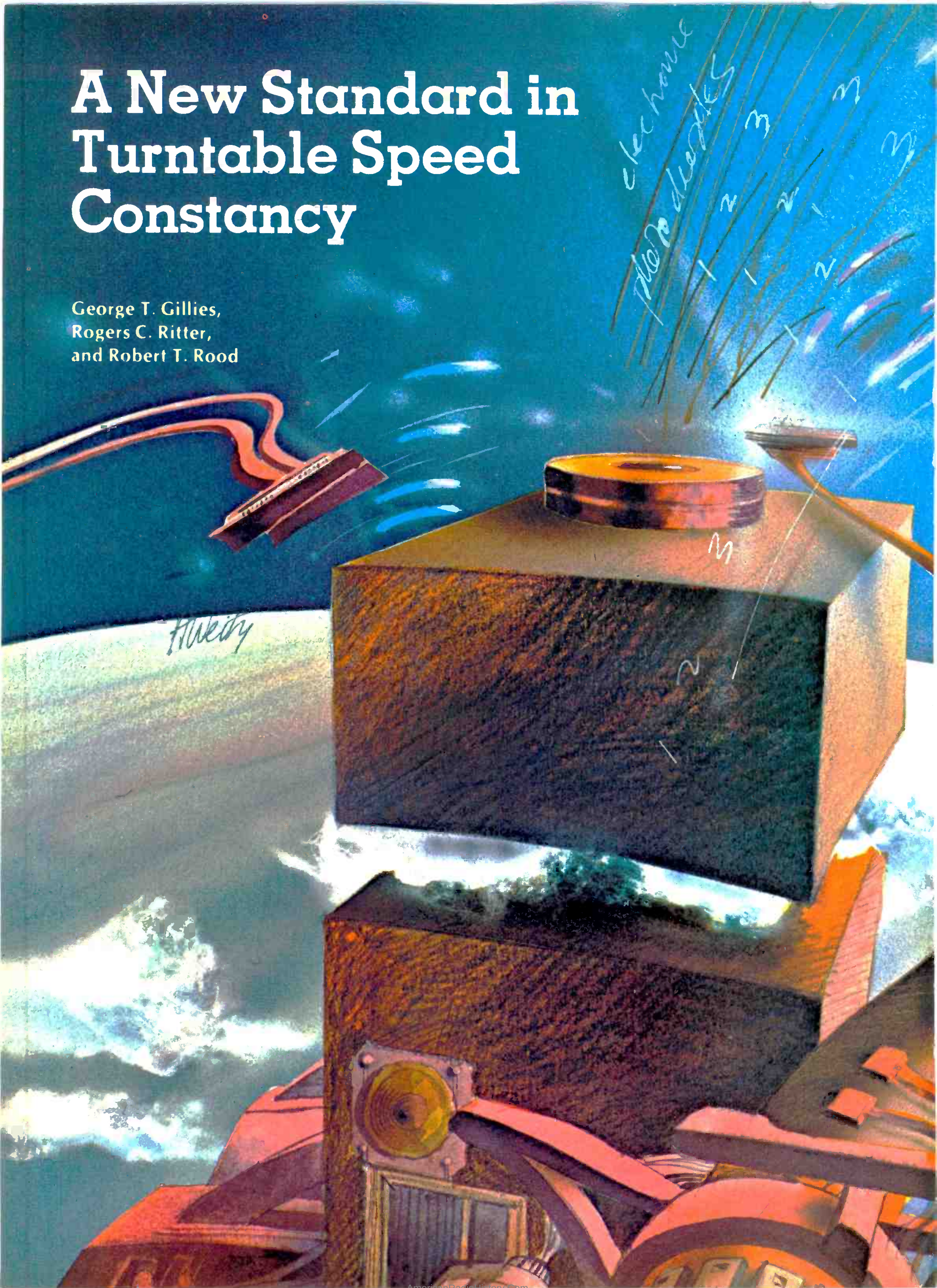
*Nationally advertised value. Actual prices are established by Kenwood dealers. Cartridge optional.

KENWOOD®

For nearest dealer, see your Yellow Pages, or write Kenwood, P.O. Box 6213, Carson, CA 90749

A New Standard in Turntable Speed Constancy

George T. Gillies,
Rogers C. Ritter,
and Robert T. Rood



The last decade has seen rapid advancement in turntable technology. Some of the models commercially available have featured precision belt-drive systems, direct-drive motors with various types of closed-loop feedback schemes and a variety of other innovations.

An important goal in engineering turntables to high standards is to reduce the wow and flutter levels to some point well below the limit of human detection.

Rotating turntables, however, also have interesting uses outside the field of sound reproduction, and one finds that for certain scientific applications, the rotational speed constancy of the turntable must be between 10,000 and 10,000,000 times better than the finest commercially available turntables.

There has been interest in developing such rotational apparatus in our physics laboratory at the Univ. of Virginia for a host of applications over most of this century, and recently we have succeeded in driving turntables at speed constancies never before achieved [1].

Our specific purposes in developing such instrumentation are three-fold: 1) We wish to do a laboratory experiment in which we can unambiguously test the theories which predict that the force of gravity gets weaker as time goes on [2]; 2) another experiment (currently underway) is one in which a study of the motion of rotating cylinders would tell us whether or not matter is being created in the universe [3], and, 3) it appears that we can test the earth's rotational speed fluctuation and wobble, measure latitude fluctuations, and study other geophysical phenomena by observing the forces acting on small masses placed on an almost totally constant-speed turntable.

Anthony Weitz

Description of the System

The turntable we are currently using for these experiments is shown in Fig. 1. It is a 95-lb. brass disc that has been mounted on an air bearing with no mechanical contact between the bearing surfaces. Instead, the rotor of the bearing floats on a cushion of air approximately 0.0001-inch thick. The turntable (moment of inertia 500 lb.-in.^{2}) is mounted on a 500-lb. granite block which rests on damped pneumatic springs which sit on an 8000-lb. granite block. This, in turn, sits on four damping isolators, each consisting of eight steel plates separated by ribbed neoprene pads.

new drive for the table consists of a special motor with certain similarities to, but many differences from, commercial direct-drive motors. It consists of 50 coils facing inward (see Fig. 2) from the stator which "write" semipermanent poles in a 10-mil steel strip around a 12-inch diameter aluminum rotor. The coils are in series with alternate ones reversed. As the rotor advances 1/25 of a turn, the drive signal has completed one electrical cycle and the motor operates synchronously. The main difference between this unit and an ordinary synchronous motor is that the partial "rewriting" of the poles each 1/25 turn ends up in an average pole position and strength being set up on the rotor. This greatly reduces the effects of pole asymmetry in position and strength and largely confines short-term fluctuations to the synchronous frequency which is much easier to filter out in the feedback system.

The drive signal has been generated from a function generator for wave-shape testing, but the precision source is a sine wave derived from a local oscillator phase locked to an atomic clock. This low-level signal is fed through a 200-watt commercial powersupply amplifier (Kepco Model BOP36- 5[M]) to drive the 15-ohm coil load. Figure 3 depicts the drive system schematically.

Other Drive Schemes

We have studied many different drive systems over the last three years, some more exotic than others, and a number of them are interesting and potentially useful. Two schemes on which we did only preliminary work are: 1) two permanent magnets were mounted on the bearing rotor, bracketing one such magnet on an arm from the stepping motor drive, and were aligned for repulsion, so that a "soft" magnetic coupling between the motor and table absorbed the sharp jumps at every step of the motor and 2) an eddy-current drive we developed consisted of permanent magnets on an arm from the drive motor being rotated near a conducting disc on the table. This last provides the requisite "soft" drive but puts considerable demands on the feedback system. Both of these drives were ultimately replaced by a mechanically coupled stepping motor drive which will be discussed later.

Consideration of Speed Constancy

For audio purposes wow and flutter are of prime concern with absolute speed accuracy secondary, as few human beings can detect 1 per cent variations occurring over a period of several minutes. For broadcast purposes the duration of a selection may be important in which case absolute speed accuracy is needed. In our research, all of these factors are important, particularly the latter, and our methods of measurement may seem unconventional with respect to present industry standards.

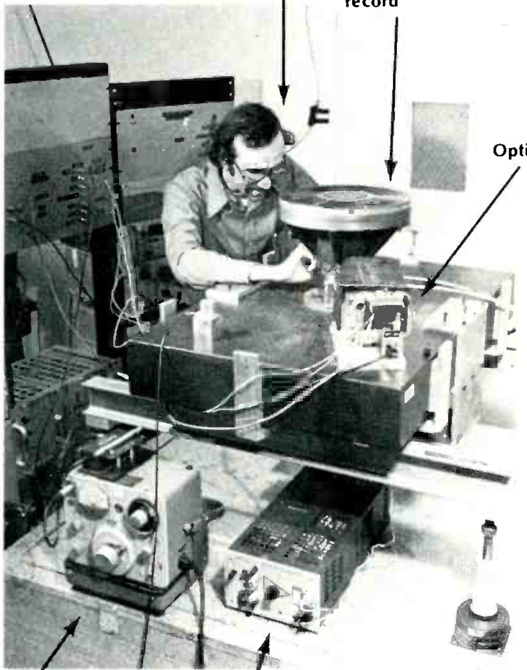


Fig. 1—The turntable, air bearing, and optical lever are shown here. They are mounted on two stages of vibration isolation hardware, each stage being composed of a massive stone block supported by appropriate spring-like couplers. Some of the electronic components of the drive and speed sensor are shown in the background.

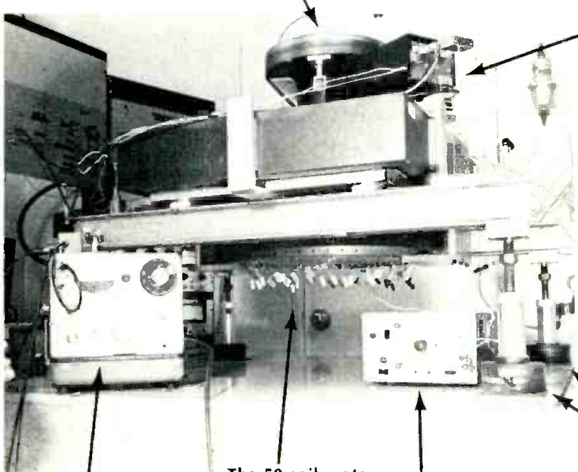


Fig. 2—The 50 motor drive coils are shown mounted on the steel stator, and the motor-drive plate is centered among them. The motor power amplifier is in the foreground.

In non-technical form the standard terms are defined [4]: "'Wow' usually refers to cyclic deviations (in the motion of the medium) occurring at a relatively low rate, e.g. a once-per-revolution speed variation of a turntable," and "'flutter' usually refers to cyclic deviations occuring at a relatively high rate, e.g., 10 Hz." Commercial turntables quote figures for both of these as low as 0.03 per cent and occasionally lower. The long-term accuracy of direct-drive turntables is usually governed by the accuracy of the drive oscillator, much as our own system. Typical quartz oscillators are good to about one part per million, i.e. to 3 sec. per month, which is also the accuracy of good quartz wristwatches.

For audio purposes such accuracy is sufficient but when one is studying a force like gravity which may change by as little as one part in 100 billion per year, speed drift must be much lower. Wow and flutter are somewhat less important since such effects average out in a long (one to two month) measurement provided they are small enough in magnitude, less than 0.000001, so that they do not generate effects in the signal through non-linearity.

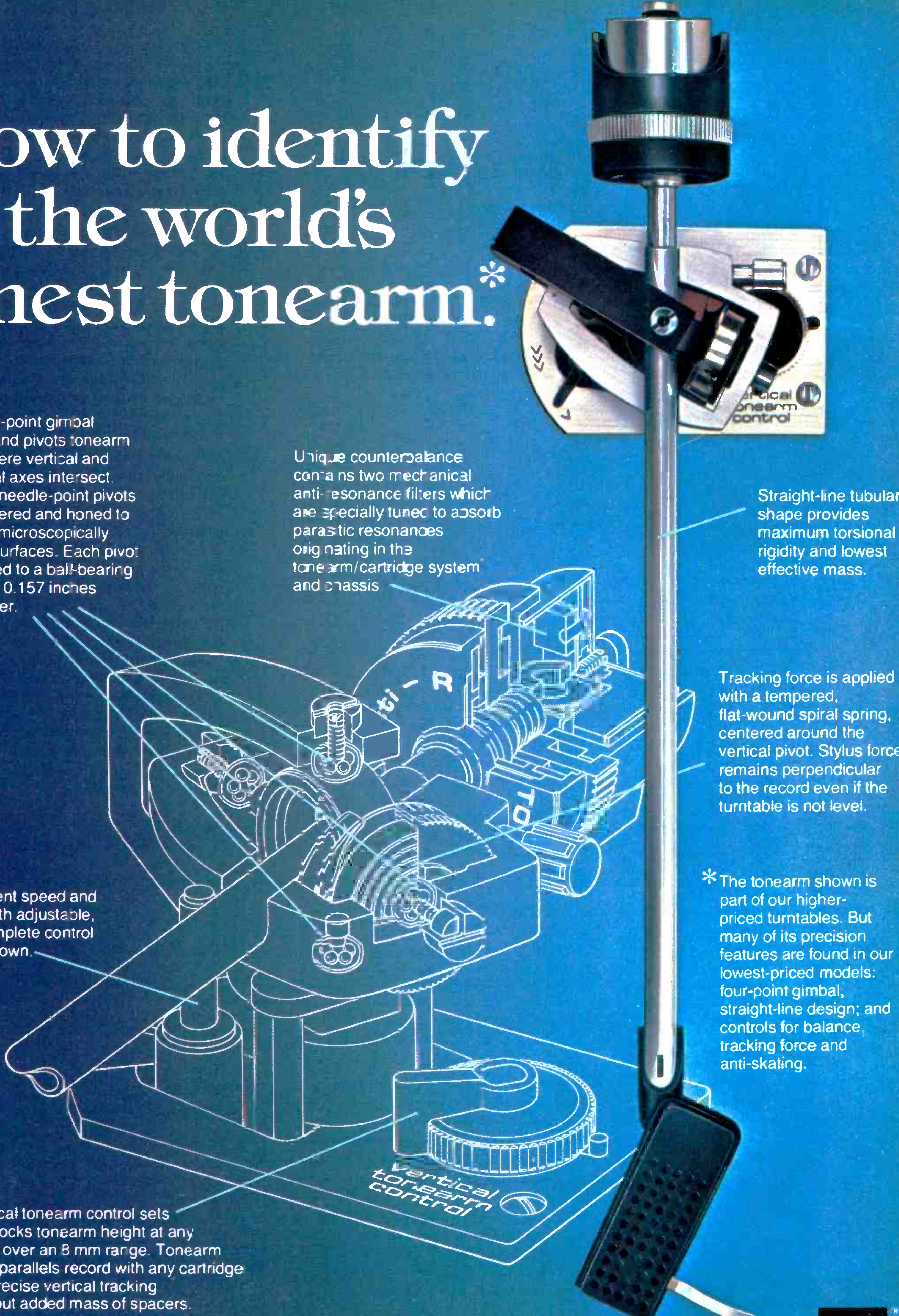
Performance Measurements

One basic measurement of the turntable was in the undriven mode, determination of the Q or quality factor of the table. This was found from the slope of the exponential decay of the periods in coastdown tests and has the value of about 3000 at 33⅓ rpm. (This number varies by about 10 per cent over a wide range of speeds.) This means that the *decay time* of the turntable is about 860 sec., i.e. the table speed falls to 37 per cent of its initial value in this period of time. It will coast visibly for more than an hour.

The method of measurement used to obtain the coast-down results and others described below was to measure the periods of rotation. A block diagram of the method is shown in Fig. 4. An optical system called a "Jones Lever" uses a light source and split silicon photo-diode with appropriate lenses and slits which generate a pulse upon the passage of a mirror mounted on the table. A fast counter times pulse intervals. In principle, the timing resolution can be made as low as 0.00000001 seconds with this method, but with our simplified version the rotational periods were timed to about 0.000002 second. For a speed of 15 rpm this limits the measurement of fluctuations in the rotational periods to no better than 5 parts in 10 million.

Careful measurements of individual periods have only been made on the

How to identify the world's finest tonearm.*



True four-point gimbal centers and pivots tonearm mass where vertical and horizontal axes intersect. The four needle-point pivots are tempered and honed to produce microscopically smooth surfaces. Each pivot is matched to a ball-bearing race only 0.157 inches in diameter.

Unique counterbalance contains two mechanical anti-resonance filters which are specially tuned to absorb parasitic resonances originating in the tonearm/cartridge system and chassis.

Straight-line tubular shape provides maximum torsional rigidity and lowest effective mass.

Tracking force is applied with a tempered, flat-wound spiral spring, centered around the vertical pivot. Stylus force remains perpendicular to the record even if the turntable is not level.

Cueing descent speed and height are both adjustable, providing complete control of stylus setdown.

*The tonearm shown is part of our higher-priced turntables. But many of its precision features are found in our lowest-priced models: four-point gimbal, straight-line design; and controls for balance, tracking force and anti-skating.

Vertical tonearm control sets and locks tonearm height at any point over an 8 mm range. Tonearm thus parallels record with any cartridge for precise vertical tracking without added mass of spacers.

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Dual

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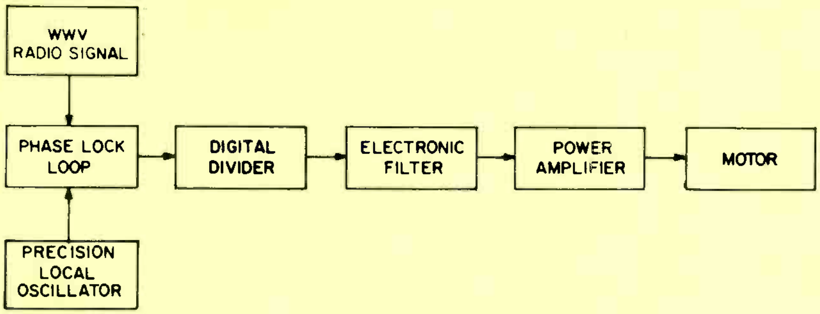

Fig. 3—The local oscillator output is phase locked to the WWV reference signal. After digital division and reshaping of the waveform, the resultant signal is amplified and used to drive the motor coils.

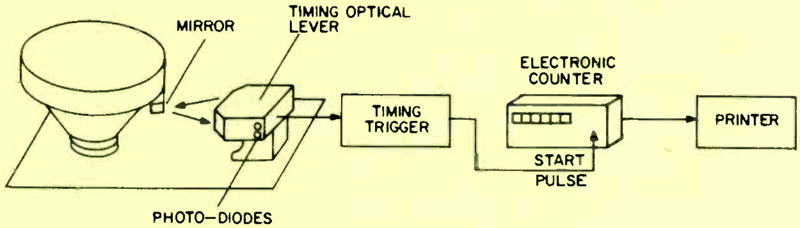

Fig. 4—The optical lever sends a light beam towards the table and receives a reflected light pulse from it once per revolution. The timing trigger provides a uniform pulse for starting and stopping the counter. The counter output, the rotation period length, is then printed on paper tape for later analysis.

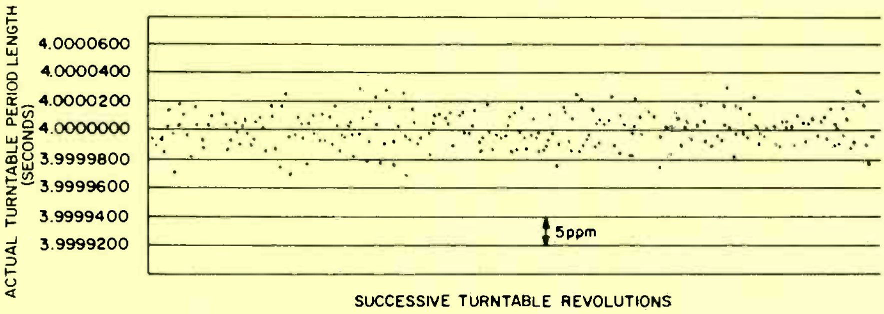

Fig. 5—Typical data depicting the small fluctuations in the driven turntable period are shown here. Each plotted point represents a single measured turntable rotational period.

old, unfedback, stepping-motor drive. Figure 5 shows a typical set of measurements of individual periods at 15 rpm for about 200 periods. The standard deviation of these is about ± 5 parts per million and none exceeded ±8 parts per million. Thus the wow is less than ±8 parts per million or 0.0008 per cent.

Long-term variations were measured by averaging over times corresponding to 10, 100, or 1000 periods, thus bypassing the timing limitation mentioned above. This was done automatically by setting the 8-digit electronic counter to time and average these decade multiples of periods. In good runs the variations were a few parts in 10 billion over 1000 revolutions. That is, the average speed variations over 1000 periods were about 0.00000003 per cent at 15 rpm.

When reaching into regions of precision such as this, the reference clock for timing and for the drive must be much better than the usual temperature-controlled quartz oscillator. We used a local quartz oscillator phase-locked to a radio signal from WWV. Due to atmospheric variations the received WWV signal varies over short time periods, but this is averaged over long-term measurements: Thus our stability over short periods, e.g. an hour, was set by the local oscillator, this one having frequency fluctuations which were typically 0.0000000001; longer periods would have a precision traceable ultimately to the atomic clock at the National Bureau of Standards in Washington.

The measurement of flutter at levels of interest to us is a more difficult problem. As yet, we have no numerical results though we estimate that flutter with the old drive was comparable to the wow and will be better with our new drive.

A system for measuring flutter is now in the early test stages. It consists of the following: Laser light is diverged to a 3-inch diameter beam and passed through two 12,000-line transmission-type encoder plates, one stationary, and the other rotating with the table. The transmitted, fluctuating light is then converged onto a silicon photodiode and the resulting electrical signal is amplified and analyzed. Although noise and alignment have prevented us, thus far, from using this system near the limits of its capability, we can, obviously, expect ultimately that Fourier analysis of the signal will lead to a very sensitive measurement of all flutter components up to about 10,000 Hz before aliasing sets a limit.

Our vibration isolating system is

The limited edition NR-1415. An important statement in pure power, styling and luxury of features.

It's an AM/FM stereo receiver with character.

View the features and controls that abound on the distinctive front panel. Features that let you be creative or simply listen to one of the world's finest receivers.

Looking inside, the tuner section has three dual-gate MOS-FETs to provide high gain, better selectivity (65dB normal/85dB narrow) and improved sensitivity (1.7μV normal/2.0μV narrow) when combined with a five-gang capacitor, the largest available.

Nikko engineers employ high gain and high performance ICs in the AM section and a phase-lock-loop FM multiplex circuit to minimize noise levels and offer quieter performance.

Power Amp Section

For added smooth operation, four phase linear ceramic filters in the IF stage provide better separation and less distortion, effectively separating weak stations from strong stations.

To balance the quality engineering of the NR-1415 and for wide bandwidth performance, a direct-coupled OCL pure complementary power amplifier is at the heart of the power section. It's the best signal amplification system ever devised.

And when combined with dual power transistors in parallel, the result is power and distortion figures which best Nikko's own heavyweight pro amp, the Alpha I.

In case you're wondering, the NR-1415 effortlessly supplies 175 watts per channel, continuous power output, into 8 ohms, both channels driven, 15 to 20kHz, with no more than 0.045% THD.

Dual power supplies (an independent positive side and independent negative side), are one reason for increased dynamic range. The power sections, and heavy-duty heat sinks, are easily removable, typical of Nikko's dedication to reliability and serviceability.

Protection Circuit

Other examples of Nikko's technology leadership are a very sensible—almost wireless—connector system as well as a double protection circuit to maintain the NR-1415 at peak efficiency.

In case you missed noting all the front panel controls, there's mic mixing and choice of normal and narrow FM bandwidth.

Nikko engineers thought of everything and left out nothing. Yet, it's original and affordable.

That's why the NR-1415 is Nikko's ultimate receiver.

Nikko Audio

For those who take their stereo seriously

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In Canada: Superior Electronics, Inc. © Nikko Audio 1978

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very effective in that the residual vibration levels are below our ability to measure them. With a Mechanalysis Model 350 Analyzer and its #544 probe, we find an average vibration level of about 10 micro-inches peak-to-peak on the floor, but internal instrumental noise completely overides any vibration on our table at a level of about ½ micro-inch rms.

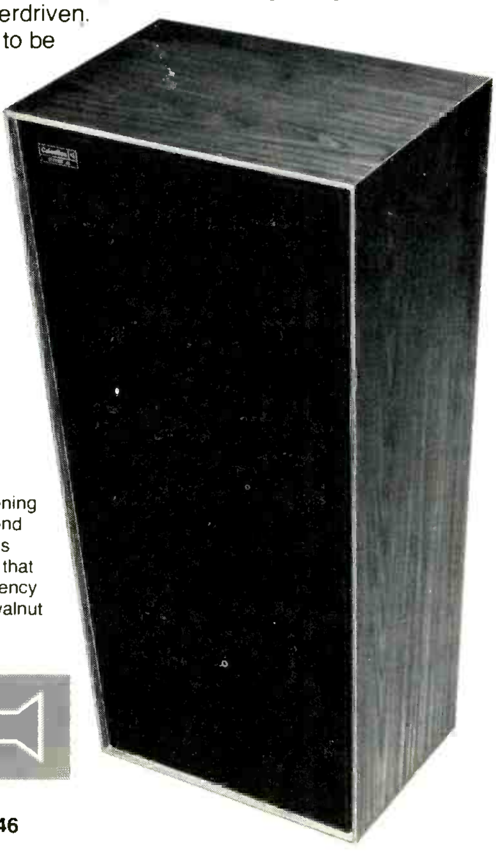
Future Work

If vibration ultimately is still a problem, we will install a feedback system to correct this. It consists of three plates separated by two sets of stacked piezo-electric crystals. The upper "sensing" set senses remaining vibrations and puts out a signal which is amplified and fed back out of phase to the lower "motor" set which cancels out the vibrationally induced motion. In one such system at The International Bureau of Weights and Measures, Sevres, France, the vibrations are reduced by a further factor of 100.

Clearly, such measures as the above are not needed for everyone's stereo turntable, but for those of you interested in having a setup like this in your den, the price tag is roughly $30,000.

Finally, such a turntable needs a suitable cartridge and tonearm. In a future article we hope to report on the laser-optical pickup system we have conceived. Finely-focused laser light is guided to and servoed onto the record grove; then position-sensing detectors produce the two components of the stereophonic signals. A microprocessor sorts out the signal from record imperfections (the noise) by spectral analysis and provides appropriate control for the light beam as well as processing the signal. Such a system will be most useful if it can function with current records, and it seems likely that it can. The overwhelming advantage of such an arm is the delicacy with which it treats your records. The "stylus force" is only 0.000000000000000000000001 gram.

1. G.T Gillies, *Development of a Constant Speed Drive*, Masters Thesis, University of Virginia, 1976.
2. R.C. Ritter and J.W. Beams, "A Laboratory Measurement of the Constancy of G," in *On the Cosmological Variation of the Gravitational Constant*, ed. P.A.M. Dirac and Leopold Halpern, (in press).
3. R.C. Ritter, G.T. Gillies, R.T. Rood, and J.W. Beams, "A Proposed Dynamic Measurement of Matter Creation," *Nature 271*, 228(1978).
4. *Reference Data for Radio Engineers*, International Telephone and Telegraph Co., (H. Sams and Co., Indianapolis, 1968), section 28, page 21.



We just raised the standard of the industry.

The new Koss PRO/4 Triple A.

We did it again. We took the incredible sound and precision craftsmanship of the Koss PRO/4AA that has long made it the standard of the industry and made it even better. Because the PRO/4 Triple A's extra large voice coil and oversized Triple A diaphragm reproduce a dynamic, full bandwidth Sound of Koss that carries you back to the live performance like nothing you've ever heard before. You remember it all: the expectant hush of the crowd . . . until suddenly . . . the night explodes with the glittering splendor of the all engulfing performance. You're drawn to the full blown fundamentals and harmonics of each instrument. To the spine-tingling clarity of the lead singer's magical voice. To the rhythmic kick of the drum and the throbbing of the bass.

You see it and hear it all again, yet you're relaxed at home in your own private realm of listening pleasure. The PRO/4 Triple A's extra light construction and unique Pneumalite® suspension dual headband make wearing them as much of a pleasure as listening to them. And all the while, the Triple A's special, human-engineered, direct-contoured Pneumalite® earcushions create a gentle yet perfect seal for flat, low bass response to below audibility.

It's a whole new experience in stereophone listening. A new performance standard for those who set their standards high. Write c/o Virginia Lamm for our free full-color stereophone catalog. Or better yet, take your favorite records or tapes to your Audio Dealer and listen to them like you've never heard them before . . . live on the new Koss PRO/4 Triple A.

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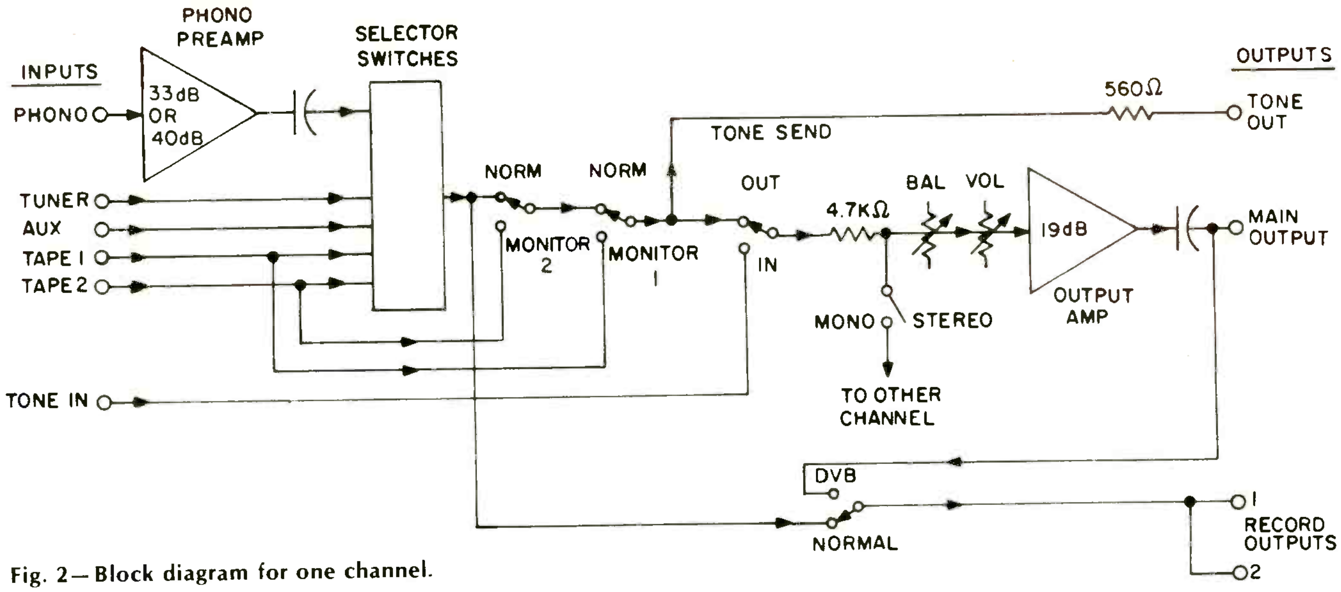
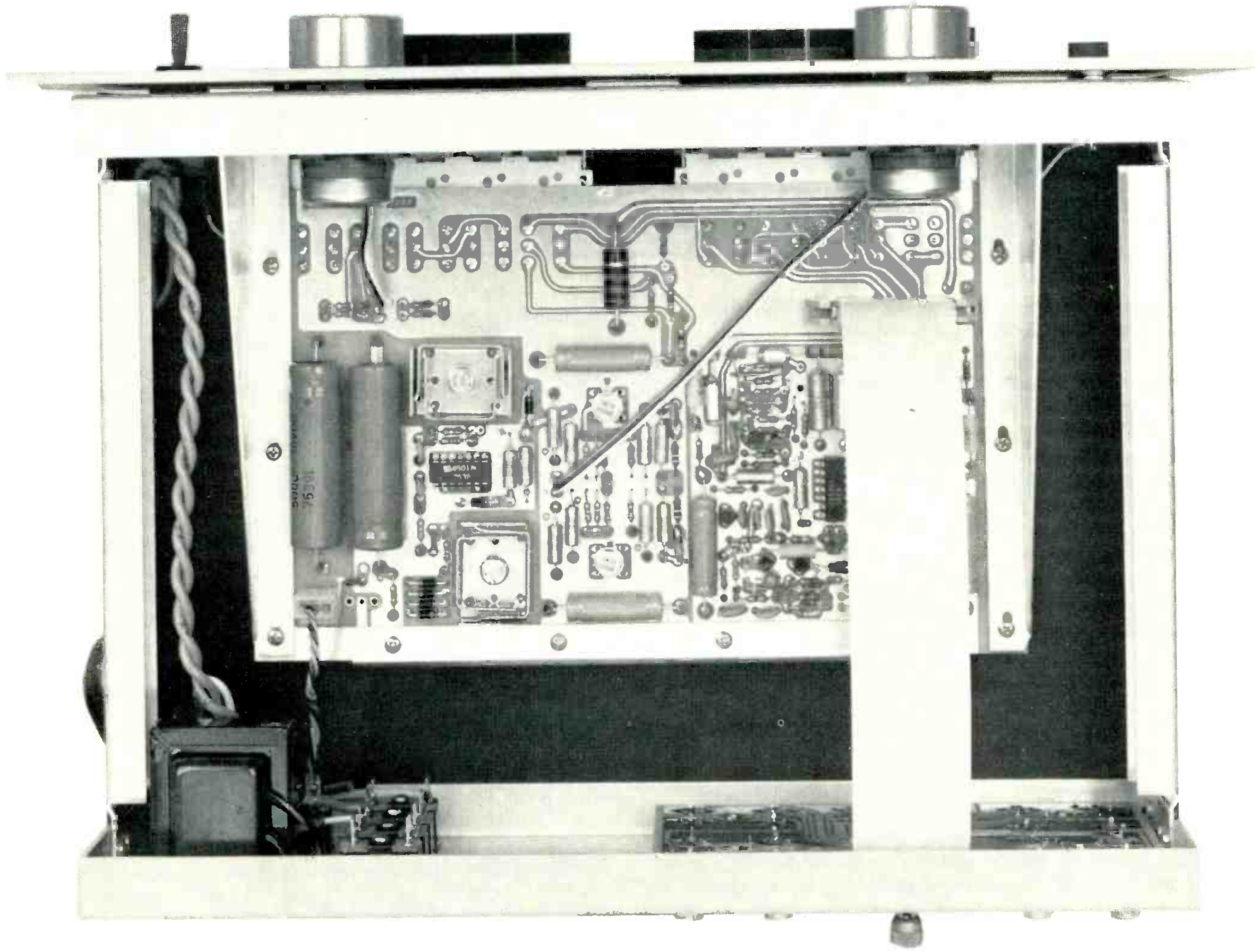


Fig. 2—Block diagram for one channel.

This IC is a new generation device which includes FETs in the input and output stages, offers unusually high speed, and good output drive capability. Figure 2 is an overall block diagram for the preamp.

Measurements

The 511 is a good performer on the test bench. No distortion measurements are plotted since the distortion was below the residual of the instruments when using a Sound-Tech 1700A and a Crown IMA. Let it suffice to say that at 2 volts out of the phono preamp or 8 volts out of the main outputs, the IM distortion was below 0.002 per cent when loaded with 10 kilohms, and the THD was below 0.002 per cent at any frequency from 20 Hz to 20 kHz with same load. (It is expected that the distortion would be lower with higher impedance loads.)



INTRODUCING THE TEAC C-1.

We took a data recorder made for computers and built a cassette deck made for connoisseurs.

If you're critical about what you listen to, you should see the new TEAC C-1.

The C-1 has a transport directly derived from recorders built by our Instrumentation Division for the world's major computer manufacturers.

Its motors are rated for thousands of hours of continuous use. Servo controls have a reliability factor of 10^8 and function switches are built to withstand repeated use in excess of 100,000 times.

WHY THE TRANSPORT IS SO IMPORTANT

For the C-1 to deliver the kind of virtuoso performance we promise, it has to meter—not pull—tape with the utmost reliability. And that's a matter of mechanics, not electronics.

The sad fact is, many tape recorders are built by electronics companies with a short history of transport design. And transport mechanics is where most tape recorders break down.

Transport design—using materials that move and interact—is no simple science. It's an art that takes a long time to learn.

The art of mechanical design is one we've been practicing for more than 25 years. And it reaches a high point with the C-1.

THE TRANSPORT

The C-1 transport is a 3-motor/3-head dual capstan system. The closed loop dual capstans are linked with twin belts to produce a wow and flutter spec of just 0.04%. The capstan motor is phase-locked loop, so it's free from voltage and frequency fluctuations.

C-1 pinch rollers are self-adjusting to get optimum tape pressure onto the capstans. Transport controls are LSI logic-operated and positive. Separate right and left input controls are cross-geared with friction coupling for one-hand control of channels.

A pitch control lets you vary tape speed up to ± 4% (because tapes you get from others may not be as accurately recorded as those you give).

THE ELECTRONICS

There isn't a cassette deck made that can beat this combination of specs: overall frequency response with CrO_2—20-20kHz, other—20-18kHz; Wow and Flutter—0.04% NAB, weighted; and Signal-to-Noise ratio—−70dB with Dolby at 5kHz and up to −90dB with optional dbx interface module (Rx-8).

Another unique feature to the C-1, are plug-in bias EQ/cards that let you optimize the electronics to a specific brand of tape. Additional cards are available for various brands of tape. For distortion-free recording, peak program meters respond to signals with an attack time of 10 milliseconds in all audio frequencies and give you an accurate display of peak level up to +5dB.

Other C-1 features include an input selector switch for Mic/Mic-with-attenuation (20dB pad)/Line; a timer control for automatic record/playback start; a memory function for Auto-Stop/Repeat; and a folding stand for vertical or angled use. Naturally, the C-1 can also be rack mounted.

HOW MUCH

The TEAC C-1* has a suggested list price of $1300, a lot of money by some standards. But when you consider its computer/instrumentation heritage—and what that means in terms of how long and how well it will run—it could be the most inexpensive tape recorder you can buy.

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First. Because they last.

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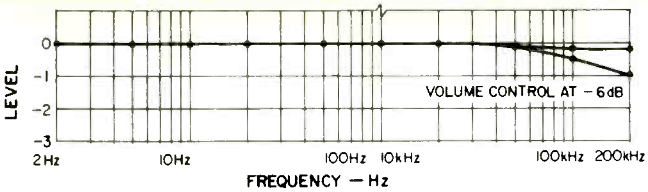


Fig. 3—High level output frequency response.

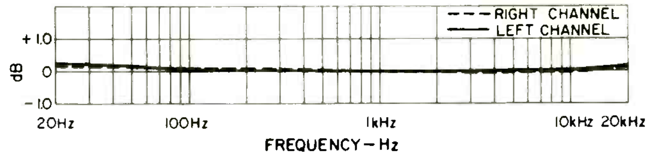


Fig. 4—Phono equalization error.

Frequency response of the output amplifier can be drawn with a ruler from 2 Hz to 20 kHz, and at the worst case setting of the volume control (—6 dB)was only down 1 dB at 200 kHz (See Fig. 3). Figure 4 shows the phono equalization error from 20 Hz to 20 kHz. Specifications on this unit could read ±0.1 dB which is very good.

Figure 5 is an oscilloscope photo showing the preamp response to a pre-equalized square wave. The top and middle traces are the response to a 1 kHz input (scales 1 and 0.1 V/division), and the bottom trace is the input and, therefore, ideal response. Audio General's literature on the 511 shows much more impressive performance on a similar test. Their measurements indicate a small signal rise time of 10 nS and a delay time of 3.5 nS. *Audio* measured 85 nS rise time and 30 nS delay time. (To put these times in perspective, just remember that light travels in space about 1 foot in one nS. See the insert on page 92 for a pictorial explanation of rise time and delay time). The difference between the measurements made by AGI and those made by *Audio* might be due to the difference in the input and output points used for the two tests. AGI disconnects the ribbon cable from the main PC board and goes in with a 50-ohm terminated source. They then monitor the output before the output decoupling network, L1 and R1. *Audio* uses the phono jacks on the rear panel for input and output—which is the way the preamp is normally employed. David Spiegel, President of AGI, maintains the test does show the inherent speed of the amplifier, and that as a result of that speed, the stage will not misbehave when faced with moderate amounts or r.f. interference. The preamp is, in fact, quite immune to r.f. interference. Conventional input filters can be just as or more effective in suppressing such interference, though it should be pointed out that input filters present a complex load to the phono cartridge and in some cases could cause a frequency response problem.

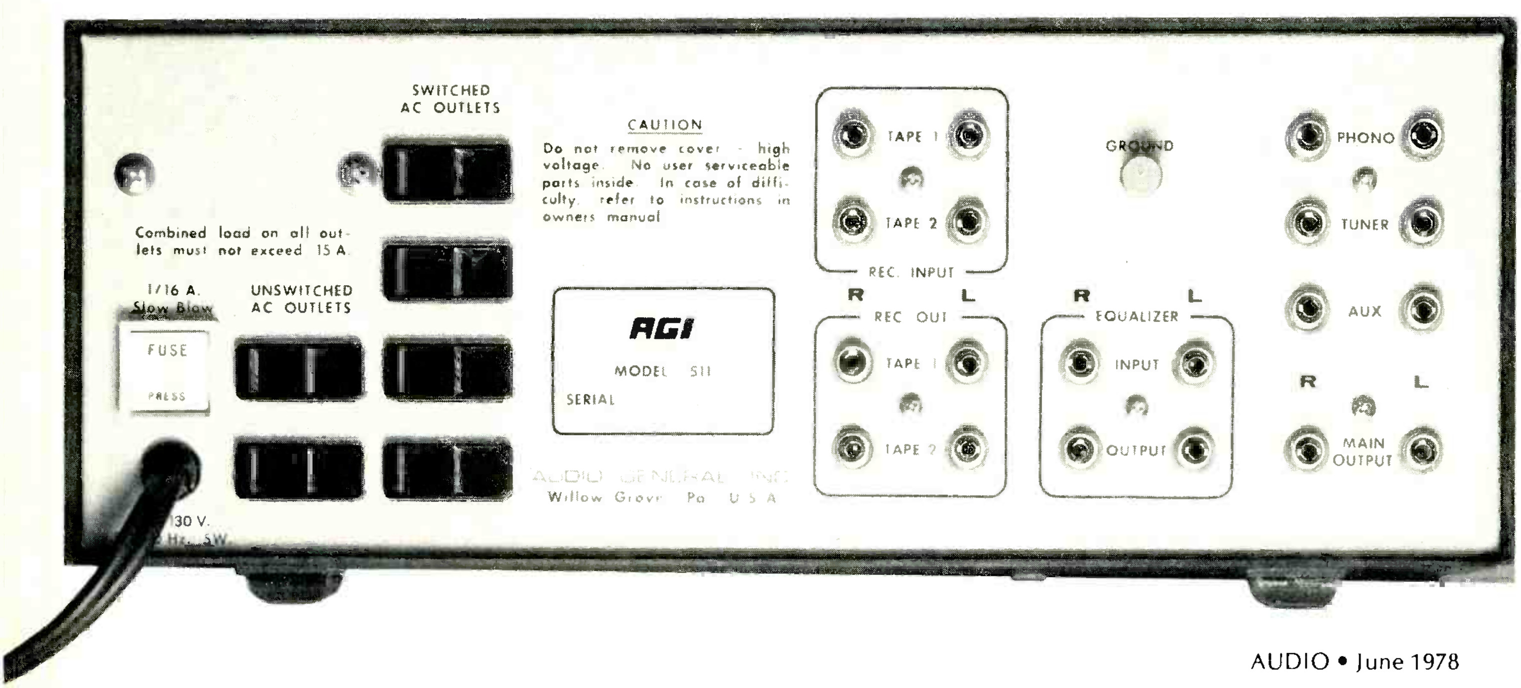
Table 1 shows output amp noise and volume control tracking error as a function of volume control attenuation. As usual, the readings are band limited to either 20 Hz to 20 kHz or 400 Hz to 20 kHz. The full range measurements will always be higher, which is most often due to hum and 1/f noise (a crude measure of semiconductor quality and reliability). However, the ear's sensitivity to low-level, low-frequency noise is so far down that fairly large quantities of noise below 400 Hz may be inaudible. Hence, the 400 Hz to 20 kHz noise column gives the best indication of the quantity of audible "hiss." Tracking error is acceptable over most of the control's range, but could be a minor irritation in systems that use efficient speakers, a sensitive power amplifier, and a high-output cartridge.

Phono preamp noise measurements are shown in Table 2. The first two columns are the conventional measurements made with a shorted input. The third column shows the increase in noise due to a 100 mH termination instead of the short. This measurement gives a better indication of the noise performance of the preamp when used with a real cartridge. Ideally, the reading should be the same; in the case of this preamp, the noise is still low enough to be useable with any cartridge save a moving-coil type. Signal-to-noise ratio is about —89 dB when referred to 10 millivolts.

The remaining bookkeeping is compacted into Table 3. The consistency of the R and L channels gives a clue to the accuracy of the gain determining components. Notice that the gain of the phono preamp in the unit tested is about 33 dB. This is 7 dB below the more standard 40 dB at 1 kHz. By ordering the 40 dB model, a more usual signal level will be available at the tape output jacks, but the input overload levels will be reduced by the same amounts, i.e. 2.24 times lower. Naturally, the output level of the cartridge will be the determining factor.

Listening Tests

This review is being published later than originally planned because of some very interesting circumstances. The preamp's designer, Mr. David Spiegel of Audio General, came to this reviewer's home with a special double-blind switching



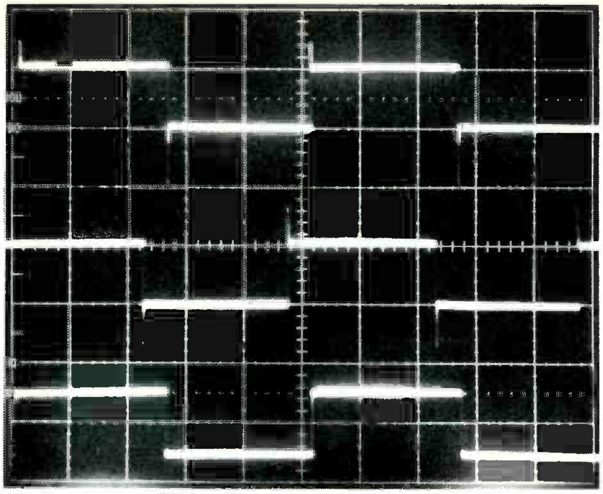
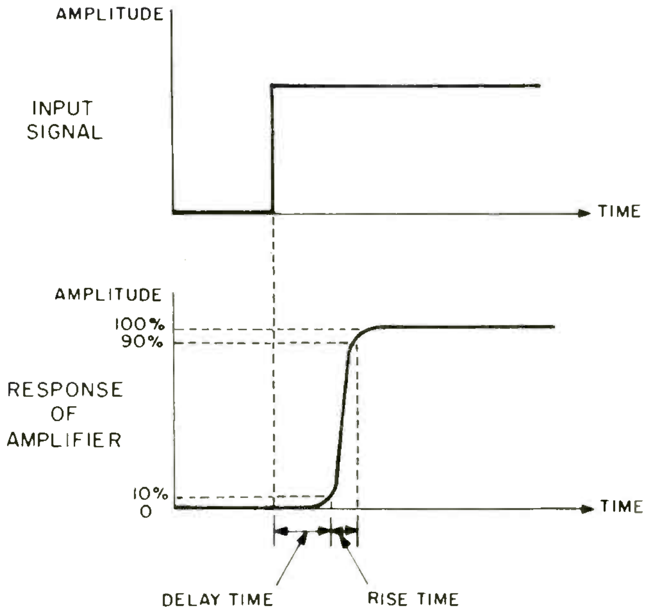


Fig. 5—Response of phono stage to pre-equalized 1-kHz square wave. Top and middle traces are at Tape Out with 12-pF load at 1 V and 0.1 V scales per division, respectively, while the bottom trace is the test signal. (Note: Center trace shifted left for clarity; time scale for all traces 0.2 mS/div.)



Pictorial explanation of delay time and rise time.

box that enabled listening test subjects to make A/B listening comparisons with the AGI and other preamps.

In addition to the usual A and B buttons, this box has three unmarked selections. The box internally programs each of these three other buttons to either A or B; its selection does not change during the test run. Since the programming is done electronically and randomly, no one knows which buttons are A and which B. The goal of the listener is to identify the mystery buttons by matching them to the certain A and B buttons. When the subject listener has reached his conclusion, a command to the box will cause it to display the answers and prepare another random selection for the following test run.

Table 1—Volume control tracking error and output amp noise.

Attentuation	Trk. Error	Noise 20-20k	Noise 400-20k
0 db	0 db	24μV	23 μV
−5	+ .8	31	31
−10	+ .6	29	29
−15	+ .4	27	26
−20	− .3	24	24
−25	+ .1	23	22
−30	+ .6	22	21
−35	+ .4	21	21
−40	+ .7	21	20
−45	+ .7	21	20
−50	+1.0	20	20
−55	+2.5	20	20

(*Editor's Note*: Audio General tells us that units made after August, 1977, have better tracking due to computer optimization of the volume controls, so that error is typically less than 1 dB from 0- to 60-dB attenuation.)

Mr. Spiegel began the testing by carefully matching the balance, volume, and frequency response of the AGI to several quite different preamplifiers. Various listeners undertook the task of identifying the AGI. At their disposal were numerous disc recordings, several outstanding phono cartridges, a pair of high-quality speakers, and the best headphones. The startling results of this double-blind test were that none of the listening panel, including this reviewer, could distinguish between the AGI and any one of the several other units during the course of a single listening session lasting several hours!

However, at a later date, another subject, also a member of the editorial staff of this magazine, was consistently able through several tests to identify the AGI using an A/B/C switching system randomly and secretly connected to make the AGI one choice and a previously used preamp the second choice. This same subject also consistently identified the AGI's high-level stage, adjusted for a gain of 1, when compared to two pieces of "wire." This subject's short-term listening evaluation and subjective comments agree very closely with results and comments made by this reviewer after weeks of extended listening prior to the first A/B test mentioned

Table 2—Noise, Phono Preamp

Term.	20-20k Shorted Input	400-20 k Shorted Input	400-20 k 100 mH
Left:	454 nV	252 nV	366 nV
Right:	477	264	374

Table 3—1 kHz Gains.

Phono Preamp:	Left 43.97X	32.86 dB
Phono Preamp:	Right 44.22X	32.91 dB
High Level:	Left 8.90X	18.99 dB
High Level:	Right 8.92X	19.01 dB

Table 4—Phono preamp overload levels

Frequency	Input Level	Output Level
20 Hz	14.7mV	6.6V
50	22	7.0
100	110	7.1
1kHz	160	7.5
5	408	7.2
10	780	7.14
20	1.45V	7.1

Output Amp Overload Levels (1 kHz)

Unloaded	9.9V
10 kilohm	9.6
600 ohm	6.7

above. Upon hearing the second editor's subjective evaluation, this reviewer was again able to distinguish between the preamps. Both subjects feel that in these tests the AGI phono stage tended to brighten records relative to other quality preamps but that this was not accompanied by an increase in harshness or "high fi" sound. The high-level stage brings the spectral balance of the phono stage back into line with the reference units' overall sound, but when reproducing high-level inputs, its sonic thumbprint was apparent, as this reviewer has found with all other electronic units yet tested. Most noticeable then are a small loss of spaciousness, or three dimensionality, and a slight softening in highly complex passages. However, simpler arrangements sounded clean and pure, with plenty of punch. In an effort to resolve the disparity between the double-blind and long-term evalutions, Mr. Spiegel returned the double-blind box so that the subject preamps could again be compared. Even under these less time-constricted conditions, no conclusive listening differences were observed using the double-blind box.

(*Editor's Note*: It seems apparent too that such differences as exist after matching of gain, balance, response, etc. are quite small, may be masked by anxiety or stress, and may be so subtle as to elude even a trained listener. My own conclusion regarding the Model 511A, reached earlier during a short listening test before sending the unit to the reviewer, was that it was clearly a unit of the first rank, differed only in tiny ways from two other state-of-the-art units available at this period, and presented an alternative which was more than simply acceptable. The question of the AGI's sonic accuracy thus seems to hinge to some degree on the method used to attempt to characterize it, a situation which does not lend itself to easy resolution. Most proponents of long-term listening tests stress that subtle differences can take a long time to appreciate fully and that rapid and frequent changes between units confuse the listener, obscuring minute differences. On the other hand, some evidence shows that the less time between the comparison of two acoustic events, the more accurate the ear is in resolving differences. Advocates of controlled double-blind testing, in which a random selection is unkown to anyone, futher contend that this method avoids any human tendency to reinforce prior judgments, which can lead to consistency at the risk of inaccuracy. This is a subject presently open to much controversy, and we do not present the final word on it here. The results of these tests do, however, emphasize the complexity of the problem and the need for further research on the psychoacoustic process.)

Conclusion

The AGI 511A is one of the best built audio products available today, and it offers by far the best quality of workmanship in its price range. The engineering that went into this preamp's circuit design was also of high caliber, as evidenced by the good measurements and lack of clicks, pops, and other spurious problems. It is for these reasons that this preamp should be the unit of choice where long life, reliability, and smoothness of operation are demanded at a realistic price. *George D. Pontis*

Enter No. 90 on Reader Service Card

Janis Audio Model W-1 Subwoofer

MANUFACTURER'S SPECIFICATIONS

94 **Enclosure Type:** Slot-loaded subwoofer.

Woofer: 15 in. diameter.

Impedance: 8 ohms, nominal.

Frequency Response: 30 to 100 Hz ± 1 dB.

Dimensions: 22 in. (56 cm) x 22 in. (56 cm) x 17½ in. (45 cm).

Weight: 90 lbs. (40.8 kg).

Accessory Supplied: External electronic crossover.

Price: $650.00.

The Janis Audio Associates Model W-1 is a sub-woofer intended to extend the low-frequency capability of any existing loudspeaker system.

Designed as a floor-standing loudspeaker, the W-1 has a rectangular shape, measuring 450 mm high (17½ in.) and 560 mm on a side (22 in). Finished in natural wood, this hassock-sized enclosure houses a 381 mm (15 in) woofer which radiates sound from a slot on its periphery. The Janis W-1 is intended to cover the frequency range from below 30 Hz to 100 Hz, with the existing loudspeaker system relieved of its normal duty by being asked to only cover the frequency range from 100 Hz upward. Weighing 41 kg (90 lb.), this system is not one that is readily moved to accommodate foot traffic or cleaning.

Electrical connection is made to binding posts mounted in a recessed cavity on the bottom of the enclosure. Included in this cavity is a fuse for protection against electrical damage due to amplifier overdrive.

The use of the Janis woofer requires that the audio system be biamplified. This means that when such a system is acquired to improve bass response of an existing sound system, additional power amplifiers must be connected for each Janis

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Among the first system use of the Strokers is the improved 320 Commode Bass System first introduced in 1970. The recent rash of commode sub-woofers can be traced to this pioneering system. By retuning the enclosure (6th order Butterworth), using an 18 inch or 15 inch Stroker, and employing a special Bass Excavator equalizer, clean, thunderous sub-bass extending to 20 Hz is realized. The 18 inch and 24 inch Strokers are principally intended for professional use in earth-shaking disco and cinema special effects systems.

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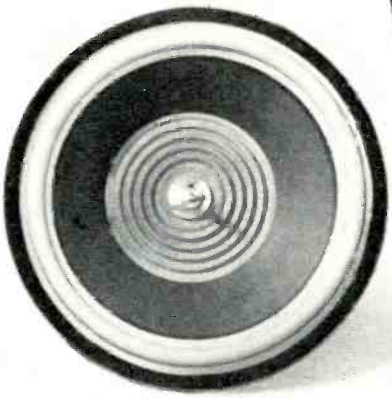
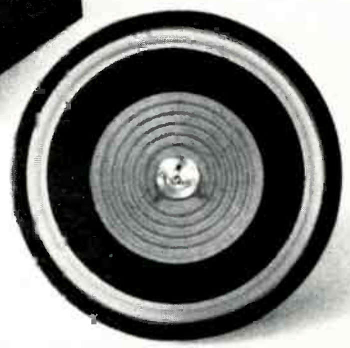
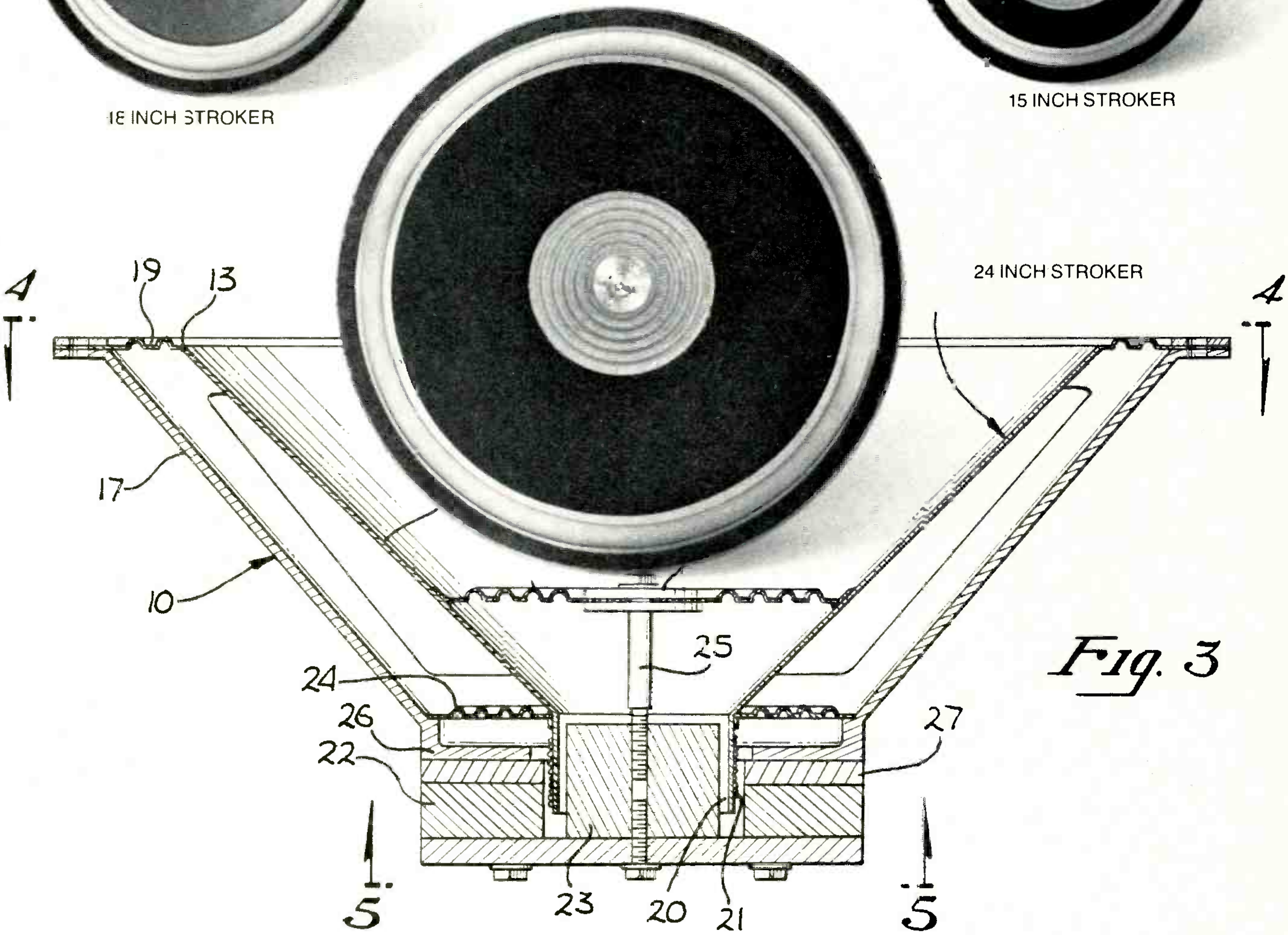


18 INCH STROKER



15 INCH STROKER



24 INCH STROKER

Fig. 3

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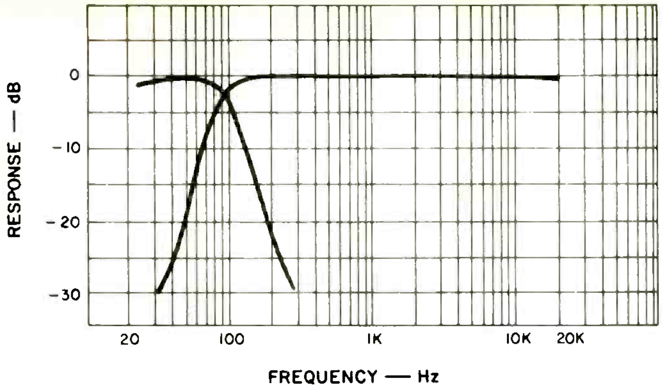


Fig. 1—Measured electronic crossover characteristics.

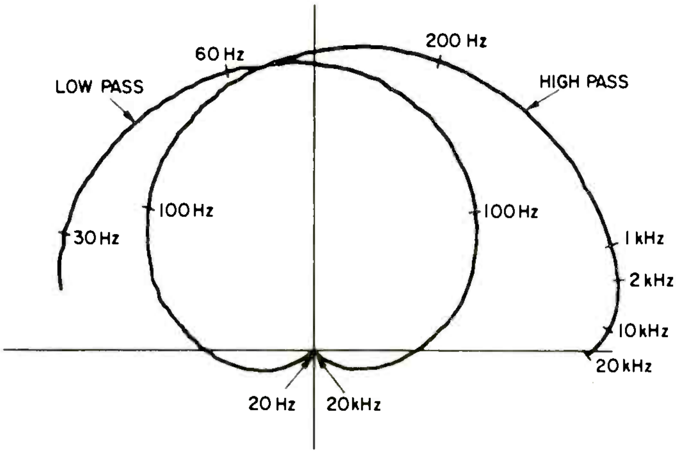


Fig. 2—Linear amplitude complex transfer function of low-pass and high-pass sections of the electronic crossover.

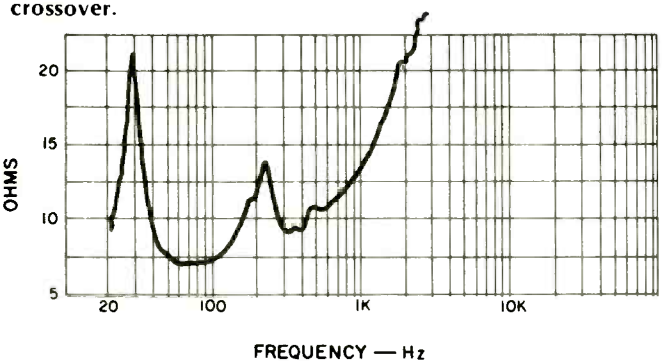
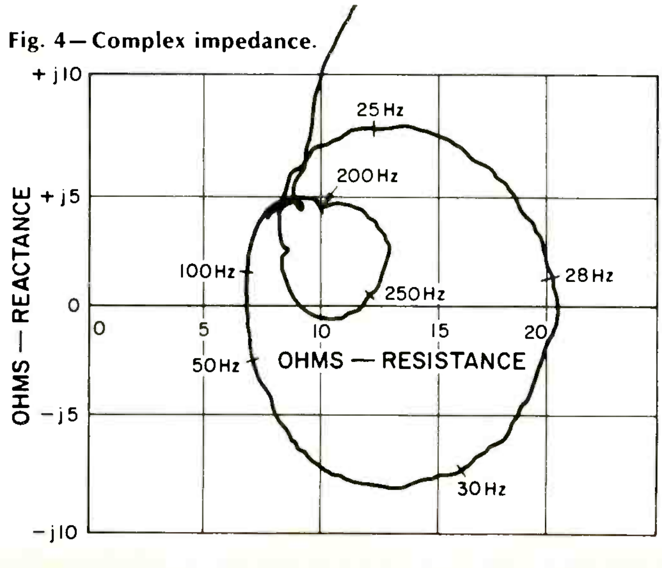


Fig. 3—Magnitude of impedance.

Fig. 4—Complex impedance.



woofer used. Fortunately, since only the frequencies below 100 Hz are affected, a single subwoofer will usually suffice, even for stereo material. A separate electronic crossover network is provided with the Janis system to give the necessary separation of signals for the subwoofer and existing speaker system. The electronic crossover is powered from house current and access to an electric outlet is required. Although there is a switch on this crossover which has "on" and "off" indications, it is not a power switch but provides a bypass mode for converting system operation to a conventional mode. When plugged in, the crossover draws a constant power of less than one watt. RCA phono jacks are provided on this crossover network to connect its output to the existing preamplifier output, and to connect its output to the power amplifiers. The voltage gain of this crossover is unity, so that no other system gain settings need to be altered.

A number of system configurations are discussed in the detailed instructions supplied with the system, and a magnetic tape is also supplied to provide test signals to assist in hookup.

Technical Measurements

The Janis woofer is supplied with an electronic crossover network which must be placed between the existing preamplifier and power amplifier. This divides the frequency spectrum into two parts. Frequencies below 100 Hz are supplied to the amplifier which will drive the Janis woofer, and frequencies above 100 Hz are supplied to the amplifier which drives the existing stereo loudspeakers. The electronic crossover supplies not only individual low-frequency outputs, should you plan to use two woofers, one for left-channel low bass and the other for right-channel low bass, but in addition a single, summed, low-pass output is provided for those cases where one woofer is used for stereo material.

The measured magnitude of the frequency response for the low-pass and high-pass sections of one of the stereo channels is shown in Fig. 1. This was measured in precisely the same manner as we use in our loudspeaker sound pressure response, except that the crossover electrical signals, rather than microphone output, were used. It can be seen that the two channels are extremely well balanced and actually crossover very close to the design frequency of 100 Hz. Perhaps a more interesting plot is the polar response on a linear voltage scale, shown in Fig. 2. The vector sum of these two channels is a nearly perfect constant amplitude with a phase angle rotation of nearly 180 degrees throughout the spectrum. Since this is a linear amplitude scale, small deviations from the ideal response are exaggerated in this presentation relative to a dB amplitude presentation.

The electrical crossover is provided with a switch to convert a stereo system from its biamped condition with Janis woofer to a conventional full-range, two-channel configuration without the subwoofer. In operation, this switch is unobtrusive and provides no discernible clicks or amplifier surges. I found this feature to be quite helpful in system setup for balance and phasing. Another important consideration is that if the crossover power plug is energized while the rest of the audio system is fully powered, there is no output surge due to turn-on.

The measured electrical impedance of the Janis woofer is shown in Figs. 3 and 4. Even though all frequencies above about 200 Hz are effectively removed by the electronic crossover, these measurements extend to 3 kHz to check for amplifier loading difficulty. The first low-frequency peak in impedance occurs at 30 Hz, with subsidiary peaks above 150 Hz. These subsidiary peaks indicate the presence of internal resonances, but they lie above the crossover range and are no indication of serious difficulty. The lowest value of impedance is approximately 7 ohms resistive and occurs at 70 Hz.

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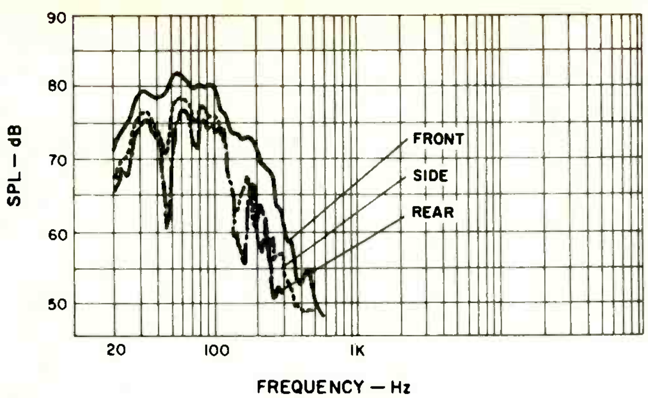

Fig. 5–One meter anechoic response with voltage drive equivalent to one watt into 8 ohms.

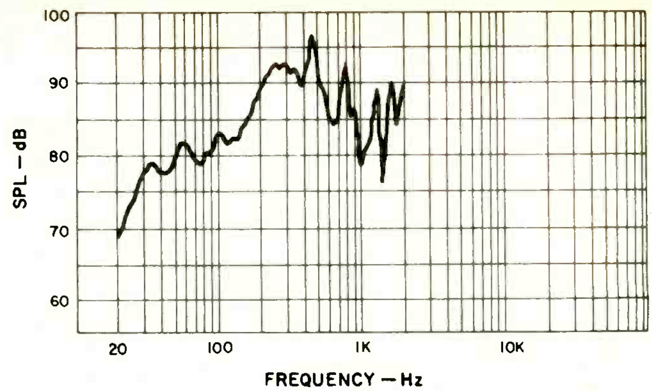

Fig. 6–One meter response measured in front position without electronic crossover network.

The measured sound pressure level curve supplied with this unit showed a textbook flatness above a low frequency cutoff of around 24 Hz. The response which I measured anechoically at one meter is shown in Fig. 5. The Janis, although visually symmetric on all four sides, actually radiates sound from a small narrow slot behind the wooden grillework on one side only.This information was not supplied in the owner's instruction manual originally packed with the unit received by *Audio*. The only way to tell which of the four sides has the slot is to tap the grille; the side with the opening will make a different sound than the sealed sides. Janis now supplies a more complete manual which mentions this important fact. I cannot help but wonder how many early Janis owners were unhappy with the sound they got by unknowingly placing the slot away from the listening area or, worse yet, flat against the wall. At any rate, the oversight has now been corrected by Janis.

In Fig. 5 the response at one meter is shown for a position directly in front of the slot, in line with one side, and directly to the rear of the slot. The electronic crossover network is included in this measurement. The on-axis response is quite uniform from around 27 Hz to 110 Hz. The acoustic output is quite low and the Janis will require from seven to 12 dB more amplifier drive than most conventional direct radiator systems with which it might be used.

Figure 6 shows the measured response when the Janis is driven without benefit of the electronic crossover. Admittedly, the Janis is not intended to be used without electronic crossover, but this measurement indicates that the user should never attempt to augment the bass response of an existing system by the simple expedient of adding the subwoofer without cutting off the bass to existing speakers or reducing high frequency drive to the Janis. It will never work out.

Because of the unusual characteristics of this subwoofer, conventional polar response, impulse, and distortion measurements are not applicable. Harmonic distortion for two low bass tone, E_1 (41.2 Hz) and C_1 (32.7 Hz) are shown in Fig. 7. The percentage of distortion agrees with the measurements supplied for this unit by Janis at the 85 dB SPL level. The harmonic distortion remains acceptably low throughout the usable power range of this system, although I would have expected to see much lower values below one average watt drive for a woofer of this quality.

The acoustic output was observed on a spectrum analyzer when a combination of two tones of various frequencies were applied to the Janis. No critical "buzzing" frequencies could be found or crossmodulation terms higher than the individual harmonic distortion values for burst powers less than about 50 watts average.

Listening Test

The Janis, being a subwoofer, must be auditioned in combination with other high quality systems, and, in order to be accurate in its assessment, was auditioned after the separate listening tests were performed on the other speakers. This was done so that proper subjective assessment could be made on the individual merits of each of the other speaker systems without the subwoofer.

In order to provide high-quality drive to all systems, a Marantz Model 510M was used as the stereo power amplifier for the wide range speakers. A single Janis W-1 woofer was used for all tests and a Marantz Model 500 power amplifier provided its drive. This power amplifier received its signal from the electronic crossover network through a Hewlett-Packard Model 463A precision amplifier. While this is not exactly your average preamplifier, it allowed for a controlled gain adjustment for matching the Janis to the other systems.

The speaker systems used with the Janis were B&W DM-6, Tannoy Berkeley, and B&O M-70 Phase Link. The position of the Janis, relative to each of the three systems differed slightly for best performance, and some readjustment of location of the three systems, compared to their use without the subwoofer, proved necessary. All systems benefited from the use of the Janis. The system helped the most is the Tannoy, while the system least improved was the B&O Phase Link.

My subjective impressions made before measurement, for the various combinations is as follows.

TANNOY There was a tremendous difference in perceived realism when the subwoofer was added. In my opinion, inverting the polarity of drive to the Janis provided a more realistic bass response than in the position recommended for this unit. There is a 100- to 200-Hz bump in response that is present with the subwoofer but not removed when the subwoofer polarity is inverted. Percussive bass has a distinct hangover which I found disconcerting, but deep bass organ pedal and other substained material are quite reasonably accurate. I found it difficult to achieve a balanced output between the two systems which would provide an optimum characteristic for all program material. That is, if I balanced the gain for what I felt was the most realistic pipe organ (I don't mean false window rattling, I mean accurate pedal balance), then the balance for other program material was slightly off.

B&W DM-6 The DM-6 is a good system in its own right. The best subwoofer location for acoustic balance with the DM-6 was flat against the center wall directly between the flanking DM-6s. I sensed that room noise realism, the shuffling, coughing, rustling between selections of material recorded live before an audience, was more realistic when the subwoofer was added. Pedal notes were clean without an

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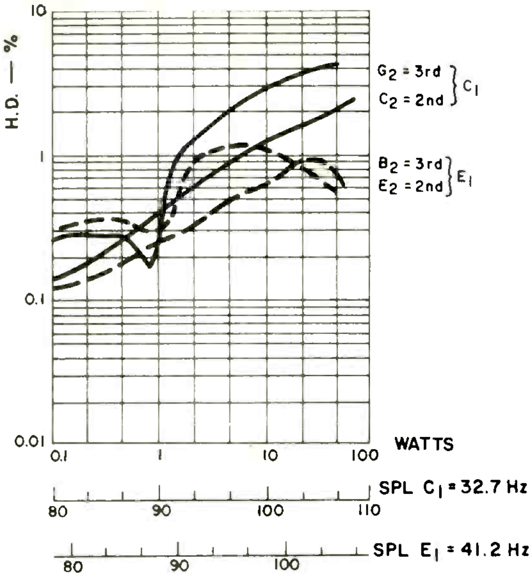

Fig. 7—Harmonic distortion for the tones C_1 (37.2 Hz) and E_1 (41.2 Hz).

overpowering sense of gut-thumping bass. As in the case of the Tannoy, I preferred the reversed-phase drive to the subwoofer. Percussive bass still had a sensation of acoustic hangover with the DM-6, but not as dominant as with the Tannoy. I originally found this baffling because the hangover sounds as though it is due to the part of the spectrum carried by the Janis. However, when I turned off the DM-6s to listen to the Janis by itself, I realized that the 100- to 200-Hz bump, which appeared with the Tannoy/Janis combination, was not present with the DM-6/Janis. This bump contributed a major part of the acoustic hangover.

B&O M-70 Phase Link The B&O does not have a super low bass of its own, but the Janis did not help these speakers as much as it did the others. The reason seems to be a dominant bass bump in the B&O which has enough energy above 100 Hz that it is excited by the high-pass signal from the electronic crossover. When I attempted to balance the subwoofer level for the most accurate sound, this mid-bass peak was reinforced by the subwoofer response in such a manner as to prevent full use of the spectrum below 100 Hz. Reversing the polarity to the subwoofer and moving it to different physical locations did not particularly improve matters. I could find combinations that flapped the shirt buttons on organ pedal notes, but piano chords did not sound right. In my opinion, the Janis made only a small improvement in the sound from the B&O Phase Link.

On an overall basis, I found that the subwoofer principally improved the spectral balance of lower pitched tones. It did not, in my opinion, either improve or degrade either the depth or lateralization of the stereo illusion. That sense of ambiance, which was enriched on percussive bass by stronger fundamental energy, was offset to some degree by the acoustic hangover on such material.

It is my opinion that for the speakers I checked, the Janis is definitely something I would recommend to augment the Tannoy. In view of the cost of this subwoofer, I would think it a toss-up whether the DM-6 warrants the additional investment. And I do not feel that the B&O Phase Link is sufficiently improved to justify the cost of a subwoofer. In other words, based on this admittedly limited experience, a subwoofer, no matter how good, is not an automatic panacea producing an overall improvement in accuracy of reproduction, but in judicious combination with another system, they can make large differences in the perceived realism of the low end of the spectrum. *Richard C. Heyser*

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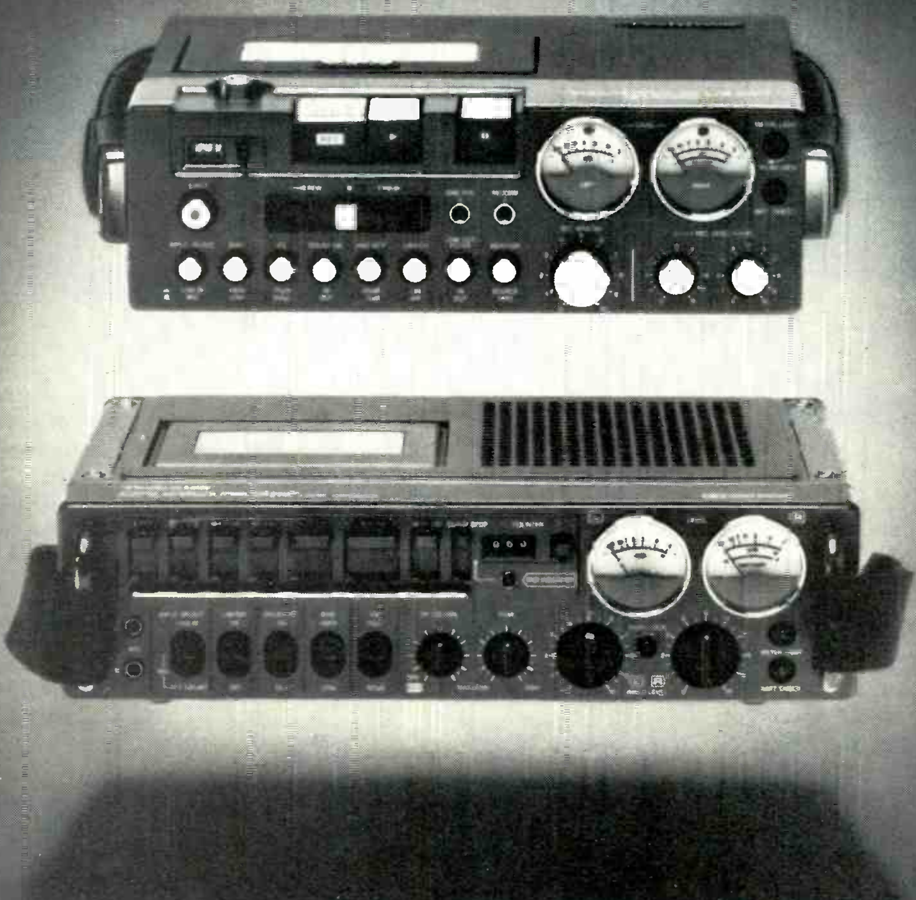

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The RS-686DS also gives you controls you won't find on many non-portables. Like a tape/source monitor switch. Low cut filter. Mike attenuator. And a three-minute tape end alert eye.

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TRACK SYSTEM: 4-track 2-channel record/playback. MOTOR: FG servo-controlled DC motor (RS-686DS). DC electronic speed control motor (RS-646DS). FREQ. RESP. (± 3 dB): RS-686DS: CrO_2 tape, 50-16,000 Hz; Normal Tape, 50-14,000 Hz. RS-646DS: CrO_2 and Normal Tape, 50-14,000 Hz. WOW AND FLUTTER (WRMS): 0.07% (686). 0.10% (646). S/N RATIO (Dolby): 66 dB (686). 65 dB (646). DIMENSIONS: 3"H x 9½"W x 7⅞"D (686). 4¼"H x 14¼"W x 11"D (646).

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Technics *Professional Series*
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Tandberg Model TR-2040 Stereo FM Receiver

MANUFACTURER'S SPECIFICATIONS

FM Tuner Section
Usable Sensitivity: 10.8 dBf (1.9 μV), Mono.
50-dB Quieting: Mono, 16.2 dBf (3.5 μV); Stereo, 37.3 dBf (40 μV).
S/N: Mono, 76 dB; Stereo, 74 dB.
Stereo Threshold: 28.8 dBf (15 μV).
Muting Threshold: 20.8 dBf (6 μV).
Frequency Response: 30 Hz to 15 kHz, +1, −2 dB.
Distortion @ 50-dB Quieting: Mono, 0.6 per cent; Stereo, 0.9 per cent.
THD @ 65 dBf; Mono, 0.4 per cent; Stereo, 0.5 per cent.
Capture Ratio: 1.5 dB.
Adjacent Channel Selectivity: 10 dB.
Alternate Channel Selectivity: 80 dB.
I.f. Rejection: 100 dB.
AM Suppression: 65 dB.
Image Rejection: 100 dB.
Spurious Rejection: 100 dB.
Stereo Separation: 100 Hz to 10 kHz, 40 dB.
38-kHz Suppression: 55 dB.

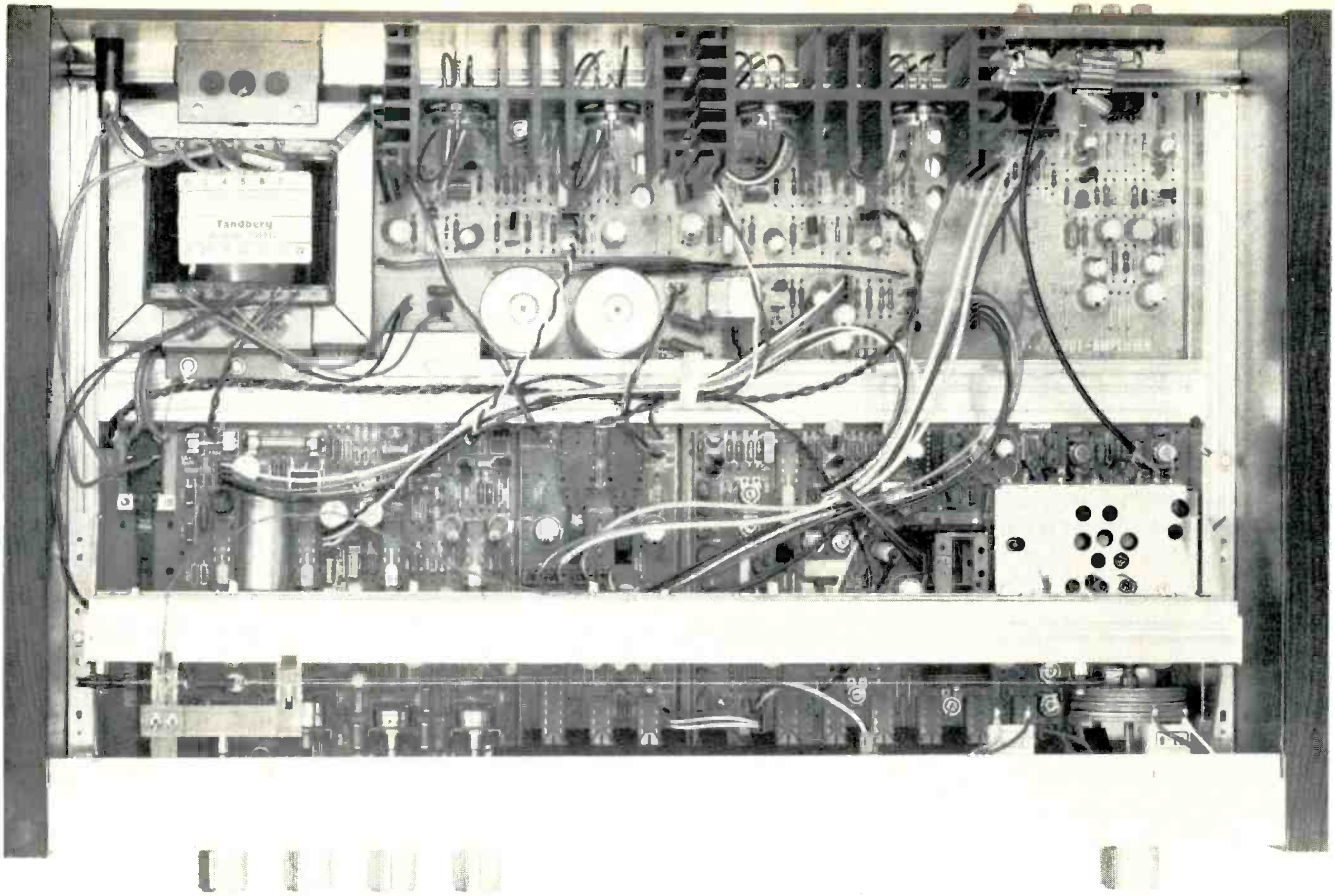
Power Amplifier Section
Power Output: 40 watts average continuous per channel, 8 ohm loads, 20 Hz to 20 kHz.
Rated THD: 0.09 per cent.
Rated IMD: 0.09 per cent.
Damping Factor: 50 at 8 ohms.
S/N @ Min. Volume: 86 dB, unweighted.

Preamplifier Control Section
Input Sensitivity: Phono, 2.8 mV; Tape, 190 mV.
Phono Overload: 90 mV.
S/N: Phono, unweighted, 66 dB re: rated input; Tape, 82 dB.
Frequency Response: 8 Hz to 50 kHz, −1.5 dB.
Bass & Treble Control Range: ±15 dB @ 50 Hz and 10 kHz.
Low- & High-Filter Cutoffs: −3 dB @ 70 Hz & 8 kHz, at 12 dB/octave.

General Specifications
A.c. Power Requirements: 120/220/240 V, 50/60 Hz, 270 W (at full power).
Dimensions: 20 ⅛ in. (51 cm) W × 5 ⅝ in. (14.3 cm) H × 12 ⅝ in. (30 cm) D.
Weight: 21 lbs. (9.53 kg).
Price: $565.00.

Every time we have occasion to unpack a Tandberg receiver (or any other of their products, for that matter), we are impressed by the ultra-clean design of the front panel, its logically arranged controls, and the distinct feeling of elegance that it exudes. The TR-2040 is no exception and is configured much like the earlier (and lower powered) TR-2025. The softly illuminated blue dial area is linearly calibrated every 0.5 MHz, and there is a channel-number scale as well (though few American users know that FM channels are assigned sequential numbers). To the right of the scale are signal-strength and center-of-channel tuning meters, also illuminated for easy visibility. The light-colored section of the panel, below the dial area, contains the major controls which include a rectangle-shaped power *On/Off* push button; rotary master volume, balance, bass, treble and tuning controls; two tape monitor switches; a phono selector switch; the FM pushbutton, and five more rectangular buttons labeled *P1* through *P5* for selecting preset stations. Tuning in these favorite stations is accomplished by means of tiny rotary controls just below each of the five preselect buttons. When these buttons are used, the signal-strength meter becomes an approximate-frequency indicator while the center-of-channel meter continues to aid in precision tuning. At the very bottom of the panel and to the left of the preset potentiometers are a phone jack, muting pushbutton, stereo-mono switch, low- and high-filter switches, speaker selector buttons (up to two pairs of speakers can be connected to the TR-2040), and a loudness button.

Connections on the rear panel of the unit caused us a few problems. While conventional screw terminals are provided for the external FM antenna connection (either 300-ohm or 75-ohm coaxial), all other connections require special multi-pin plugs—DIN type for the phono input and tape out/tape in connections and polarized plugs for speaker connections. We quickly discovered the latter plugs in a separate envelope but were a bit distressed at the microscopic hole through which one is supposed to thread the "hot" speaker leads. If, as we have all been preaching, one should use heavy-gauge speaker wires with good equipment, a user is likely to have problems trying to squeeze all the strands of an 18-gauge wire into this tiny hole provided in the accessory plugs. We also found adapter cables for the phono and tape sockets and had no trouble hooking up the phono inputs. The adapter for the tape DIN connector, however, had its pins so far recessed in-



to the shell of the connector that there was no way we could make contact to the female counterpart on the rear panel, since the shell of the adapter plug was stopped by the rear surface of the chassis itself. While we were able to come up with properly fitting DIN connectors from our stock of cables, we would like to see Tandberg pay just a bit more attention to what can be a terribly aggravating problem.

Happily, that is the complete extent of our criticism of the layout and engineering of this beautifully crafted set. As always, removal of the cabinet sections is easy, and complete access for servicing is gained once the cabinet sections are set aside. Most of the circuitry is p.c. board mounted, and all shielded cabling coming from controls and the like terminates in positive fitting plugs which pop onto clearly labeled terminals at various points on the p.c. board surface. Power heat sinks are vertically mounted towards the center rear of the chassis and seemed adequate for the power levels of which the TR-2040 is capable. Power transformer and other power supply parts are about as far away from low-level signal circuits as they could be, and the layout is in all ways typical of Tandberg quality. No schematic was provided with the unit, so we cannot comment regarding actual circuitry used except to note that varactor tuning is employed in order to provide those preset station settings. The "tuning" controls are nothing more than potentiometers of high precision which pick off the proper voltage to apply to the capacitor-like varactor diodes.

FM Tuner Section Measurements

We should emphasize what a reading of the manufacturer's published specifications already highlights. Tandberg has gone all out to comply with every last tuner specification called for in the new IEEE/IHF Tuner Measurement Standards. Furthermore, that company's penchant for conservatism in ratings holds true for this receiver. The 50-dB quieting point was attained with a signal input of only 14.74 dBf (3.0 μV across 300 ohms) in mono and 36.1 dBf (35 μV) for stereo. Best signal to noise in mono was 74 dB; 71 dB in stereo (both a bit short of claims, but certainly high enough to qualify as among the best). At 1 kHz, THD in mono measured 0.26 per cent, well below the 0.4 per cent claimed, while in stereo the THD for a 1-kHz signal was just as good, 0.26 per cent against 0.5 per cent claimed. Quieting and distortion characteristics in mono and stereo are plotted in the graphs

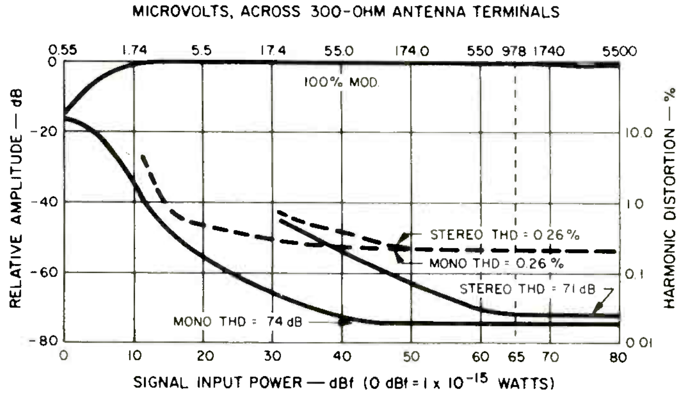


Fig. 1—Mono and stereo quieting and distortion characteristics in the FM section.

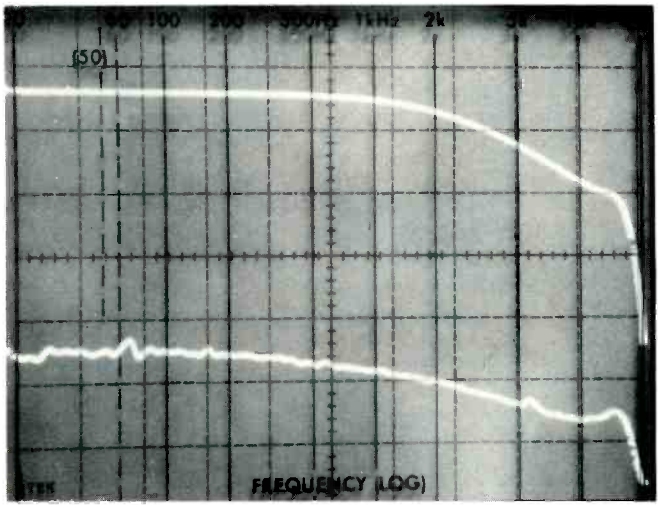


Fig. 3—FM frequency response and stereo separation, including 75 μS de-emphasis. (Vertical scale is 10 dB per division.)

of Fig. 1. Figure 2, a plot of frequency versus distortion in FM, discloses that at all but the 10-kHz test point, THD is almost as low in stereo as it is in mono. At the low-frequency end of the spectrum, it actually proved to be somewhat lower. The sudden rise in THD at 10 kHz in stereo is really more a function of stereo "beats" showing up than of true harmonic distortion.

Separation measured 47 dB at 1 kHz, 40 dB at 100 Hz, and 32 dB at 10 kHz. A complete plot of frequency response (including the 75 microsecond de-emphasis roll-off) and separation is shown in the spectrum analyzer 'scope photo of Fig. 3. Accurate design of the 19-kHz notch filter (note the slight rise at 15 kHz) accounts for the excellent response all the way out to 15 kHz which was down only 0.5 dB as against 2.0 dB allowed in the specs. Other FM section measurements made included a capture ratio reading of 1.3 dB, alternate channel selectivity of 83 dB, and AM suppression of 65 dB, better than or exactly as claimed. We measured 100 dB for image, i.f., and spurious rejection as claimed, but since that is the limit of our test equipment, one or more of these figures may actually be higher. Muting threshold was set a bit higher than claimed, at 10 μV (25.2 dBf), while stereo threshold measured 17 μV (29.8 dBf). Center-of-channel indications on the tuning meter corresponded exactly with lowest distortion tuning points as observed on our distortion analyzer, a good indication of the care that had been exercised by the factory during final alignment of the receiver.

Power Amplifier Section Measurements

At mid frequencies, the TR-2040 delivered 50 watts per channel into 8-ohm loads with both channels driven to its rated THD of 0.09 per cent. At that same output, IMD measured 0.07 per cent. Strangely, however, the IMD increased slightly at lower power output levels, though not enough to be audible under any musical listening conditions. Results of IM and THD measurements versus power output are shown in Fig. 4. Distortion at actual rated output (40 watts per channel) was a very low 0.029 per cent for 1 kHz, increasing to 0.04 per cent at 20 Hz and 0.05 per cent at 20 kHz, as shown in the graph of Fig. 5. Damping factor measured 50 at mid frequencies, as claimed. Full power for rated THD was obtained over the frequency limits of from 17 Hz to 33 kHz. If one were to rate the unit on the basis of FTC rules from 20 Hz to 20 kHz, it would qualify for a 41.4 watt rating as opposed to the 40 watts per channel claimed.

Preamplifier and Control Section Measurements

The tone controls of the TR-2040 offer perhaps more range than will be needed for most applications, greater than ±15 dB at 50 Hz and 10 kHz, as illustrated in the spectrum analyzer scope photo of Fig. 6. We suggest, therefore, that users of this receiver not arbitrarily crank these controls up to maximum boost positions (something that a great many neophytes still tend to do), since doing so might well overload the amplifier, even at nominal listening levels. When set to their flat positions (by eye, as there are no detents on the tone controls), overall response from the tape inputs to speaker outputs was flat, within 1 dB from 8 Hz to 50 kHz. The 3-dB down points occured at 6 Hz and 80 kHz. Since there is no *AUX* input pair on this receiver, all high-level measurements were made using the tape playback input, which required depressing the appropriate tape monitor button on the front panel. Via those inputs, high-level sensitivity was 190 millivolts for rated output. Signal to noise via the high level

Fig. 2—Distortion vs. frequency.

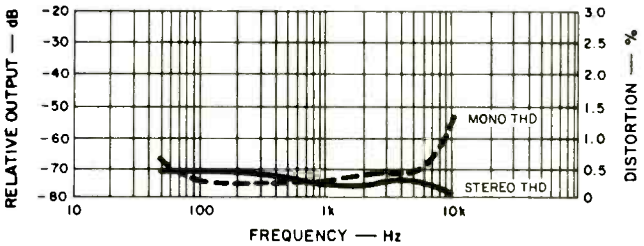
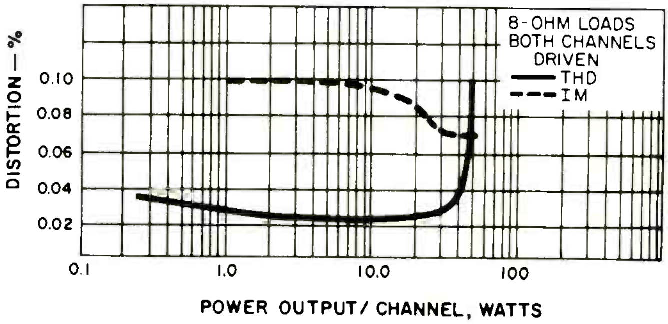


Fig. 4—Distortion vs. power output.



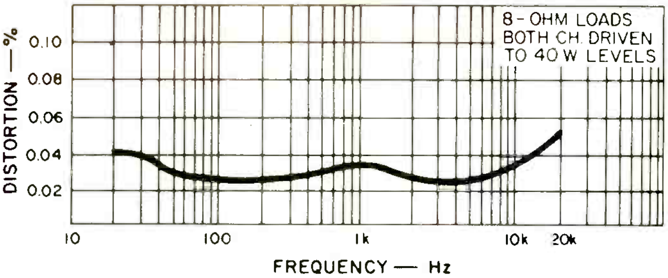


Fig. 5—Distortion vs. frequency with 8-ohm loads, both channels driven to 40-W levels.

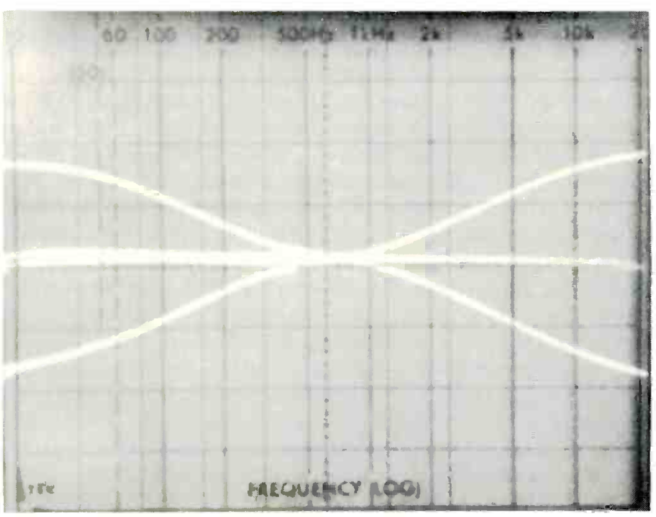
inputs measured 93 dB (unweighted), referred to rated input sensitivity and rated output. Loudness control action is depicted in the graphs of Fig. 7.

Phono input sensitivity measured 3.2 millivolts for rated output, and signals levels of up to 100 millivolts were handled by the phono preamplifier section (at 1 kHz) with no evidence of overload distortion. Signal-to-noise ratio in phono mode measured 72.5 dB, again referred to actual input sensitivity levels. The RIAA playback curve was plotted using an inverse RIAA characteristic as results are shown in the spectrum analyzer scope photo of Fig. 8. Note, that in this presentation, the vertical scale has been magnified to 2 dB per division. Nevertheless, the dip in response above 1 kHz amounts to a bit more than 1.5 dB at the high-frequency extreme—a little high for a set of this overall quality. We found that a slight rotation of the treble control to the "1 o'clock" position corrected this discrepancy almost perfectly out to 15 kHz.

Listening and Use Tests

The Tandberg TR-2040 is one of those special receivers which can neither be judged by power output nor price alone. Evaluated on a pure watts/per dollar basis, the cost seems fairly reasonable. Listened to without regard to price or power, one comes away convinced that this Scandinavian company knows something about high-fidelity sound reproduction and human engineering that many other firms seem to have missed somewhere along the line. One is not as conscious of the equipment as one is of the music, which is totally devoid of what one might call electronic coloration. Surprisingly high sound levels are achieved with no evidence of overload or amplifier clipping—further proof that the continuous power rating of an amplifier tells little about how

Fig. 6—Bass and treble control range. (Vertical scale is 10 dB per division.)



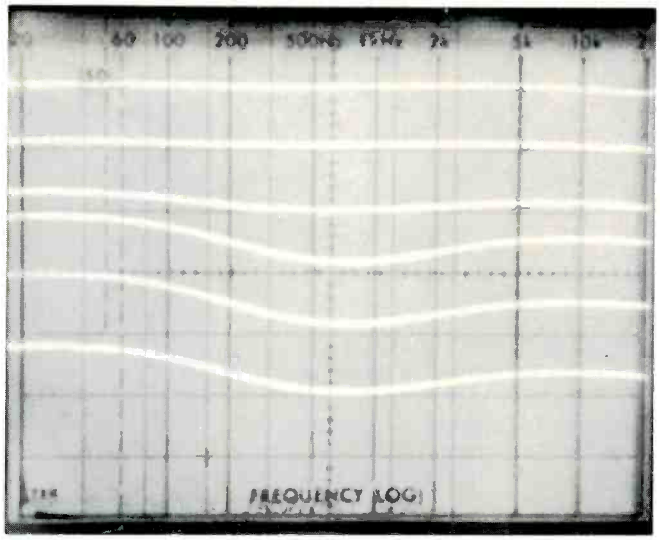


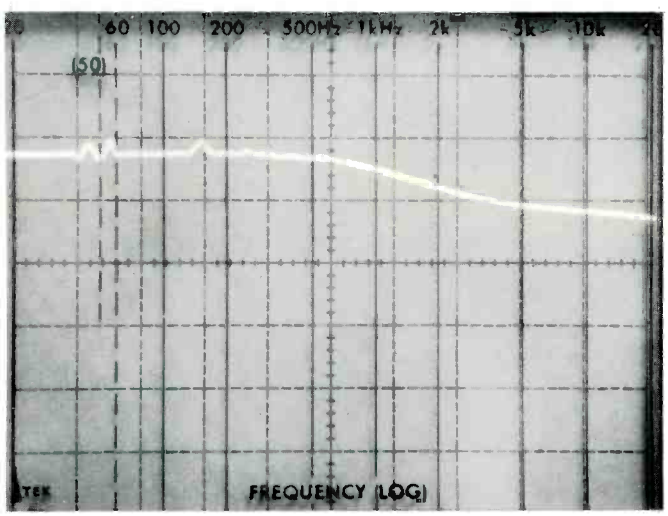
Fig. 7—Loudness control action in 10-dB increments of master volume control.

"loudly" it will reproduce musical signals. We might have preferred just a bit more gain in the phono section (to match FM levels without having to readjust the volume setting when switching from one program source to the other) but there was ample reserve on the master volume control to take care of this minor matter. A higher output cartridge would probably take care of this problem too (ours had an output of 2.0 mV for 3.54 cm/sec. velocity), but we would not recommend an overly hot cartridge for this unit because its overload reserve, though adequate, is not huge. 105

Hum and noise perceived during listening tests were both so low as to be totally unobtrusive, even during quietest recording passages on the direct-to-disc records we now use for auditioning all phono circuits of products we test. Transients in music are reproduced effortlessly by this receiver, while bass is tight and well defined. We seemed better able to single out specific musical instruments in orchestral works than we are typically able to do with most receivers in this power class. All in all, the Scandinavian alternative of which Tandberg speaks in some of its advertising is truly an alternative worth very serious consideration. *Leonard Feldman*

Enter No. 92 on Reader Service Card

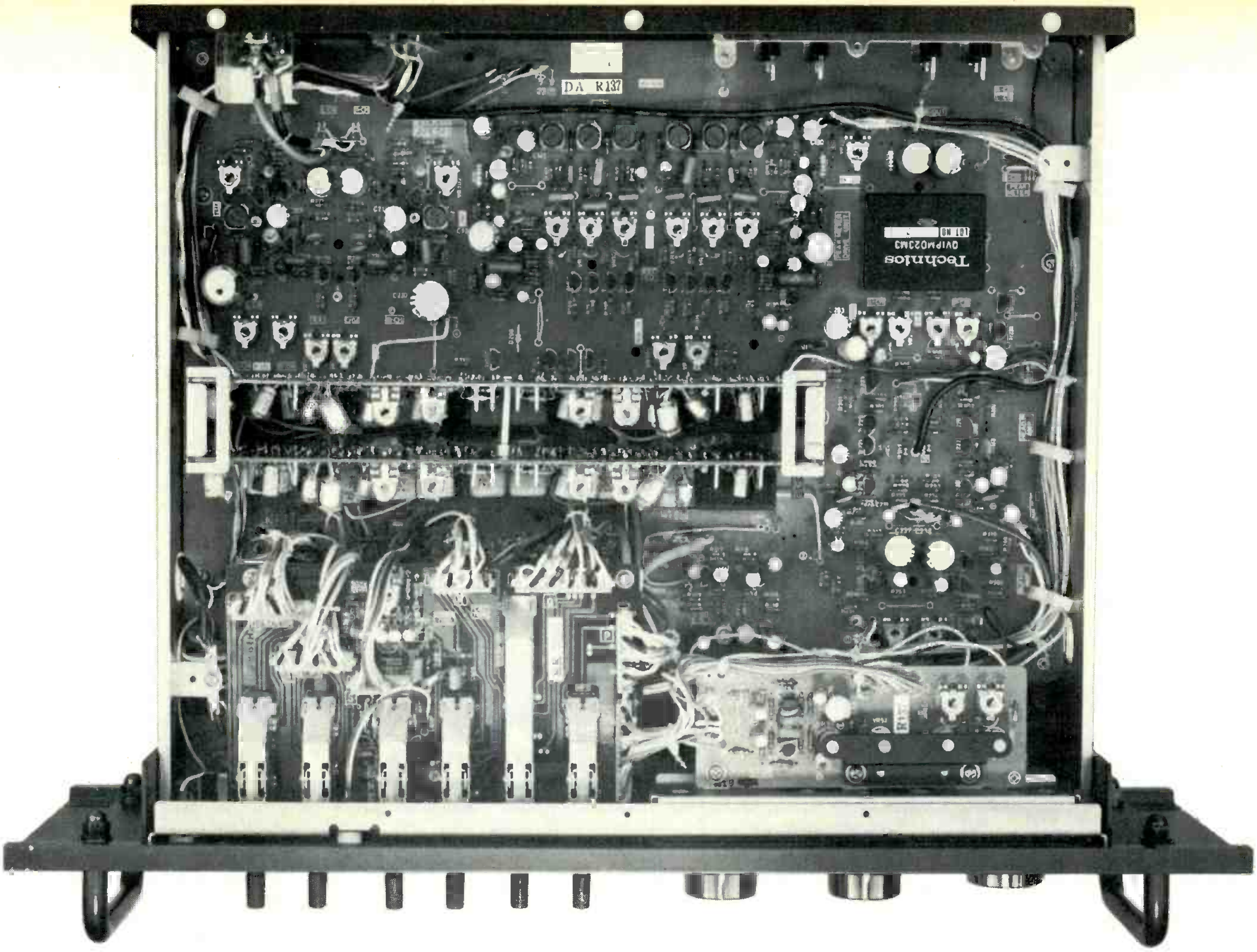
Fig. 8—Equalized RIAA phono response. (Vertical scale is 2 dB per division.)



Technics Model RS-9900US Cassette Deck

MANUFACTURER'S SPECIFICATIONS
Frequency Response: 25 Hz to 18 kHz, and 25 Hz to 20 kHz with CrO_2 tape.
Harmonic Distortion: 1.4 per cent for 333 Hz at 160 nWb/m.
S/N Ratio: 57 dB wo/Dolby, 67 dB w/Dolby.
Input Sensitivity: Mike, 0.25 mV; Line, 60 mV, and *AUX*, 60 mV.
Output Level: Line and *AUX*, 0.42 V, and Headphones, 900 mV.
Wow & Flutter: 0.04 per cent W rms.
FF & RWD Times: 70 sec. for C-60.
Dimensions: Transport, 7⅝ in. (19.4 cm) H x 19 in. (48.3 cm) W x 14¾ in. (37.5 cm) D; amplifier, 6⅞ in. (17.5 cm) H x 19 in. (48.3 cm) D. x 14¾ in. (37.5 cm) D.
Weight: Transport, 33 lbs. (15 kg); amplifier, 19 ⅞ lbs. (9 kg).
Price: $1500.00

The multi-feature, two-unit Technics RS-9900US cassette deck includes such attractions as a closed-loop, double-capstan, three-motor drive, and continuously variable bias and EQ, adjustable from the front panel. The amplifier and transport units can be operated on a table or bench side-by-side, stacked with the amplifier on top, or rack mounted in the same configuration. The panel heights are not standard, but the slot spacing does match standard racks with a total height requirement of 14 inches. The lever switches on the top left of the amplifier are as follows: *Tape/Source* monitor, *0 dB/30 dB* mike attenuator, *FeCr/Normal/*CrO_2, tape select, *400-Hz/Off/8-kHz* test oscillator, *Out/In/FM* Dolby NR, and *Out/In* multiplex filter. The oscillator is particularly useful for level setting, adjusting bias and EQ, and aligning the record head to the playback head. There is a CrO_2 status light showing whenever that bias and EQ has been selected, and there is automatic switching to CrO_2 for cassettes with the coding holes. The *Power Sentry* status light is illuminated several seconds after power turn-on, indicating that the system is ready for use. Just below, a removable clear plastic shield covers the record and play calibration pots, primarily for use with the Dolby NR. Each of the pots has a gentle detent at the center of its rotation, corresponding to the normal settings for tapes that match the preset bias and EQ, a nice, helpful touch. In the same recess is a push-button switch which selects either preset or variable bias and EQ. If *Variable* is selected, a status indicator goes on, and the single bias (both channels) and the two EQ pots are enabled. Bias can be adjusted over a range from −50 to +100 per cent relative to that for normal low-noise tape. The EQ controls provide a response change of ±5 dB at 10 kHz with gentle detents at the center of rotation. The readily available and flexible bias and EQ adjustments must be considered one of the most helpful features of this deck . . . unmatched by any other cassette unit. Headphone level has its own control, and it is not affected by the setting of the output level control. There are two *AUX* stereo phone jacks, in and out. This input can be mixed with the line input which has dual phono jacks on the back. Insertion of the mike phone plugs disconnect the *AUX* inputs. Two sets of dual, concentric pots control *Mike/AUX* level and *Line-in* level. The handy marker rings include detents when indexes line up, further increasing their usefulness. The output level attenuator-like control has 2-dB steps from +8 to −26 dB, plus settings of −29, −34, −42, and −∞. The well-illuminated meters are peak reading and cover a wide range from −40 to +5 dB, with the Dolby level reference mark at −5 dB.



There are dual line-out phono jacks on the back, which are also paralleled by the *AUX-Out* jack on the front. Also on the back are a remote control socket, a ground post, and 6- and 20-pin sockets for interconnection with the transport unit. On the top are the calibration pots for the test oscillator and FM Dolby broadcasts. Printed on the top panel is a signal block diagram and graphs of bias characteristics, record EQ range, and the peak meter dynamic response.

The large, illuminated cassette well in the transport unit contains a large mirror which facilitates observation of tape motion. *Eject* opens the air-damped, clear plastic door and lifts the cassette up, but does not propel it out. There is a manual eject button inside for use when the power is off. There is a removable head cover which provides access to the record-head azimuth adjustment and for maintenance tasks. A timer switch provides the options of starting in *Play* or *Record* when power is turned on by an external timer. The memory switch can be set for *Rew, Off,* or *Play*. The *Play* position will result in the deck going into play as soon as it has rewound to "000." These two switches, and all those on the amplifier, are spring loaded, having excellent snap-like action from one position to the other. The pitch control functions on *Play* only and allows an adjustment of tape speed of ±5 per cent. A tape time meter shows time remaining with separate

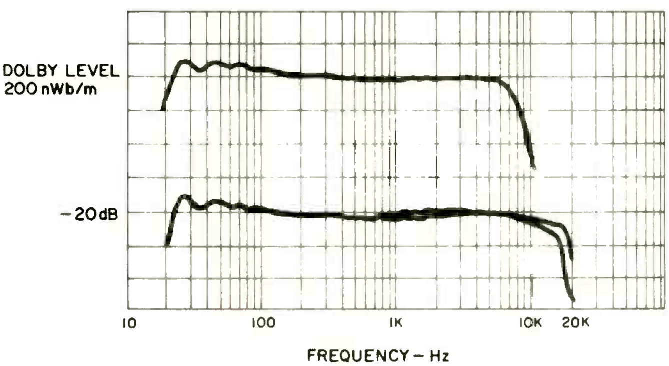


Fig. 1 — The record and playback response with Maxell UDXL I tape with preset bias and equalization, with and without Dolby.

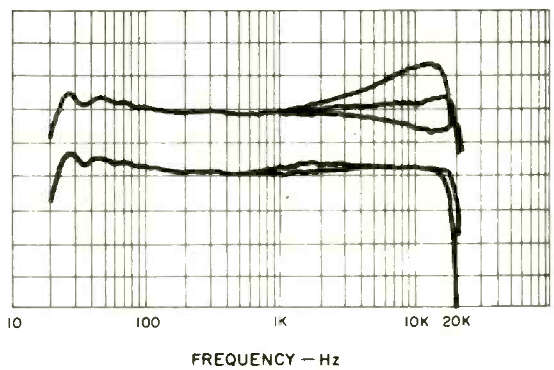
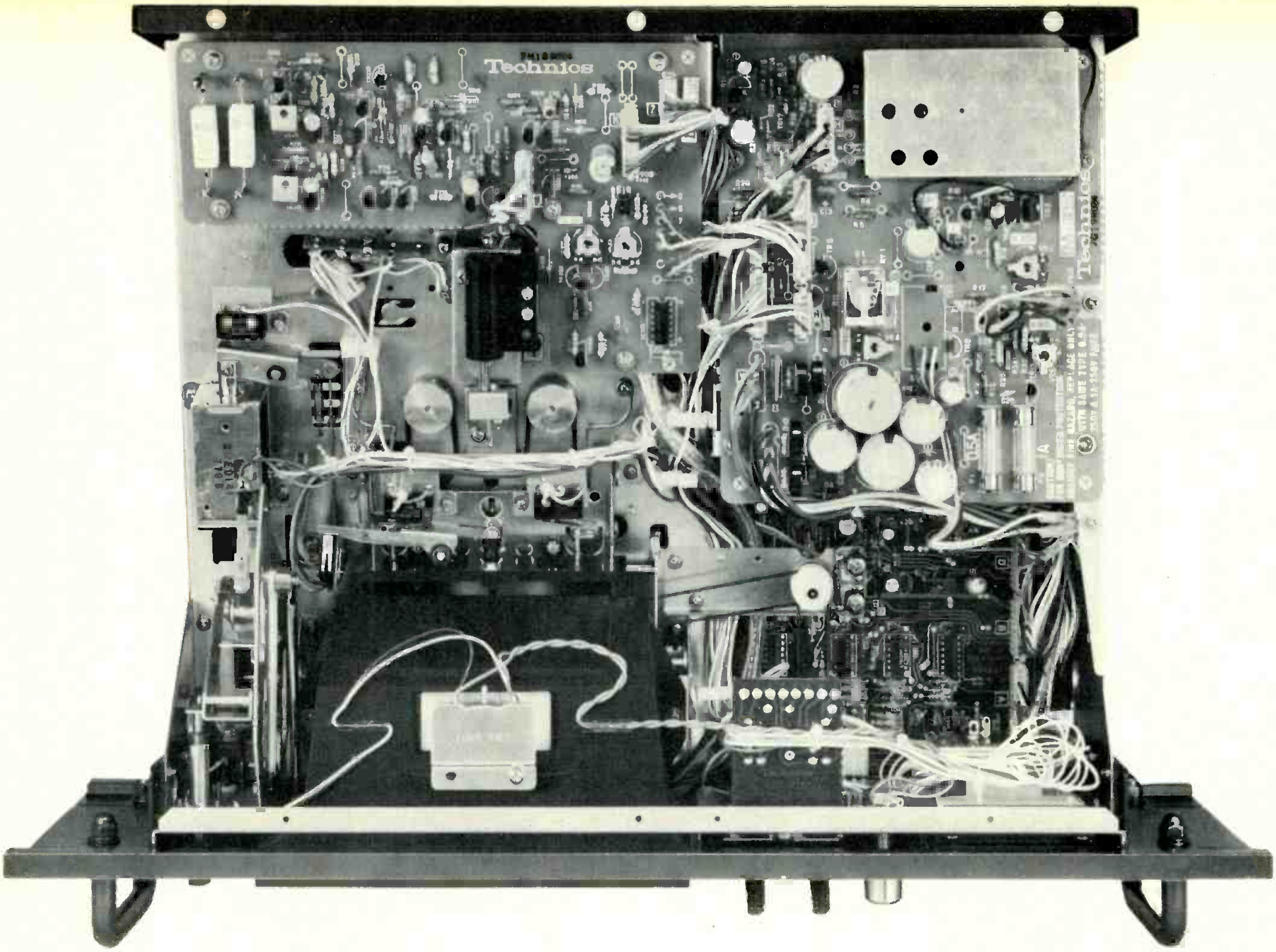


Fig. 2 — Response of the Maxell UDXL I tape with variable bias and EQ at −20 dB (re: Dolby level of 200 nWb/m). The top traces are medium bias with low, medium, and high EQ. The bottom trace is medium EQ with slight increase in bias, with and without Dolby.



scales for different length cassettes. The tape-motion logic control buttons are of the light-touch variety with status lights for each function, except *Stop*. *Record* acts as a preset in that once pushed, recording can be started by using just *Play*. The preset is defeated by using *Stop*.

The top-side and bottom covers were removed from both the amplifier and the transport. The tops of the circuit cards had very clear marking for parts, test points, and calibration and adjustment pots. The bottoms of the circuit cards evidenced excellent soldering and many helpful identifications. The construction used should aid in long-term reliability. Of particular interest was the direct-drive capstan motor with belt drive to the second flywheeled capstan. The capstan motor shaft rotates at just five revolutions per second and is of relatively large diameter.

Measured Performance

The playback responses for 120- and 70-microsecond equalizations were within 2 dB with the exception of −2.4 dB at 10 kHz for normal-tape EQ and slightly greater response above 4 kHz for the CrO_2 EQ. Using the pink-noise and third octave RTA combination, a total of 40 tape formulations were tried with the deck. About half of these matched the preset bias and EQ, although several performed better using

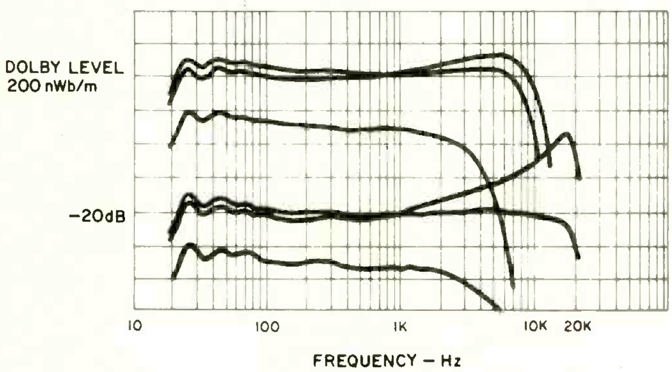


Fig. 3— Maxell UDXL I tape with variable bias settings. The EQ was at the Mid setting while the bias was changed to the Minimum, Mid, and Maximum settings.

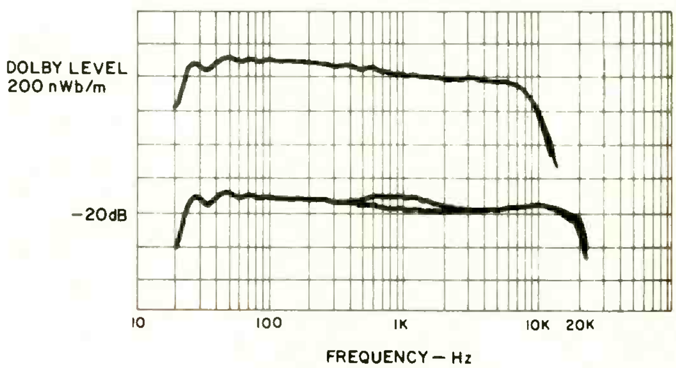


Fig. 4— Frequency response for the Scotch Master II CrO_2 tape with preset bias and EQ, with and without Dolby.

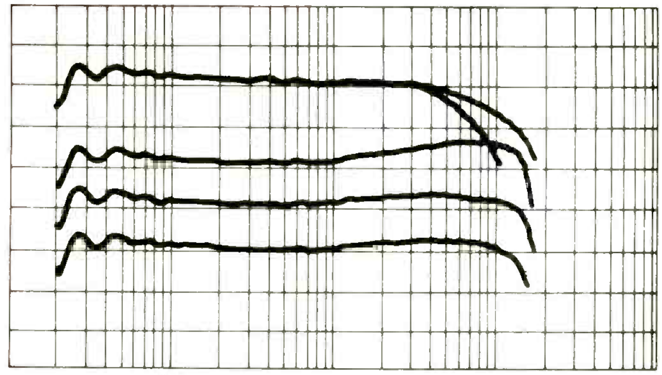
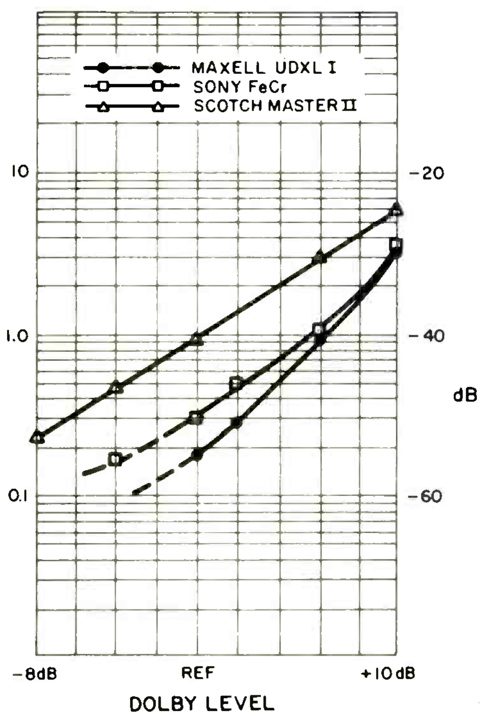


Fig. 5— BASF frequency response with both the preset and variable bias and EQ adjustments. The top trace is with preset bias and EQ (Normal setting) showing the record head adjustment to align with the playback head. The three lower traces show the response with variable bias and EQ settings.

the variable settings. Good performance for 18 of the tapes required use of the variable bias and EQ. Only one of the 40 tapes, a bargain-priced tape, could not be made to have a good response. For each of these checks, the azimuth of the record head was adjusted, using the RTA display. The built-in oscillator was switched to 8 kHz, and the record head was aligned using the indications at −25 dB on the meters. The average error of alignment was 13 degrees at 8 kHz, which would be about 1.5 degrees at 1 kHz. This result is quite good, but it did require careful attention to small changes in meter indication. The record/playback phase jitter was 40 degrees at 8 kHz, very good for a cassette recorder. At 8 kHz (8201 Hz actual), the oscillator had almost 8 per cent distortion, but this was not considered to be a limitation for its intended purpose.

Fig. 6—Third harmonic distortion level (HDL_3) vs. level at 333 Hz with the Maxell UDXL I, the Sony FeCr, and the Scotch Master II cassettes.



The Dolby level calibration was very close, with the 200 nWb/m test tape giving an indication almost exactly on the Dolby reference mark at −5 dB. The play calibration pots were touched up to make all future levels reference to the test tape used. The level of the built-in oscillator was on the nose at 400 Hz (411 Hz actual), and distortion was about 2 per cent. A number of *Record/Playback* responses were run using Maxell UDXL I tape. (Figs. 1, 2, & 3). The first set with *Normal* preset bias and EQ were quite flat at 20 dB below D.L. (Dolby level, 200 nWb/m). The responses extended from 21 Hz to 18.5 kHz, to 16 kHz with Dolby NR. At D.L., the −3-dB point was at 7.8 kHz, quite good for this level. Another set was run with UDXL I adjustments made in bias and EQ, gaining improvements in the high-end response. The Maxell tape was also used to show the range of effects from adjusting bias. As expected, the changes were dramatic, going from a +12-dB peak at 17 kHz for minimum bias to a 7-dB or greater loss at all frequencies with maximum bias. At D.L., Scotch Master II (CrO_2 EQ) with preset bias and EQ (Fig. 4) showed headroom out to 8.7 kHz, better than with the Maxell tape. At 20 dB lower, the response was from 22 Hz to 20.5 kHz, to 18 kHz with Dolby. The response with Dolby also showed a small rise in level in the mid-frequencies, as also evidenced with the UDXL I. BASF Performance (Fig. 5) was one of the tapes that had not performed that well with preset bias and EQ. Plots were made with that condition and with the record head purposely not aligned to show the need and possibility of corrections. Head alignment gained about 6 dB at 10 kHz, and bias and EQ gained another 5 dB or so and extended the response significantly. During the course of these and other tests, it was noticed that the level of residual bias in the output (when in record, of course) was very, very low. That shows excellent design and adjustment of the bias traps.

The relative distortion level of the third harmonic, HDL_3, was measured at 333 Hz (Fig. 6) over a range of record levels from 8 dB below to 10 dB above D.L., 200 nWb/m on playback (Fig. 7). Technics specifies 1.4 per cent distortion at 160 nWb/m for 333 Hz, puzzling for the choice of reference level and the fact that the actual distortion is 0.65 per cent or less at that level, *much* better than their spec. Maxell UDXL I was the best performer of the three tapes tried, with HDL_3 down almost to 0.1 per cent at the reference level. Below D.L., HDL_3 was mixed in among noise and miscellaneous harmonics generated in the electronics. This is certainly excellent low-distortion performance, but some reduction in the low-level distortion in the electronics would make this excellent machine even better. Distortion level was almost as low with Sony FeCr as with the Maxell, but notably higher with Scotch Master II. Checks with other CrO_2-type tapes showed the Scotch tape to be one of the best. The results in this case appear to be further evidence that CRO_2-type tapes will usually have higher distortion. The conclusion of this reviewer is that the relatively lower distortion figures for such tapes reported elsewhere is the result of using regular harmonic distortion meters, rather than spectrum analyzers. Because of the lower *noise* which is gained with the 70-microsecond EQ, the meter would give a lower "distortion" rating to the CrO_2-type tape. Using the same three tapes, measurements were made of HDL_3 *vs.* frequency at D.L. Distortion figures were too low at 10 dB below D.L. to obtain anything but partial data at the frequency extremes. Particularly noteworthy are the low distortion levels at the lowest frequencies.

Signal-to-noise ratios are referred to the "maximum recording level" in the 9900 specs, and the assumption was made that Technics was using HDL_3 = 3 per cent as that point.

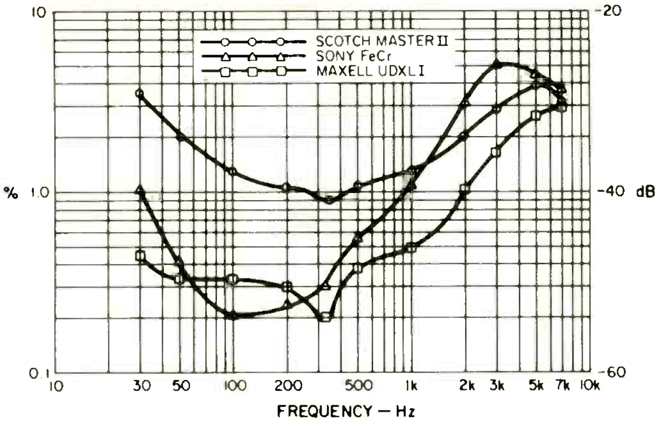
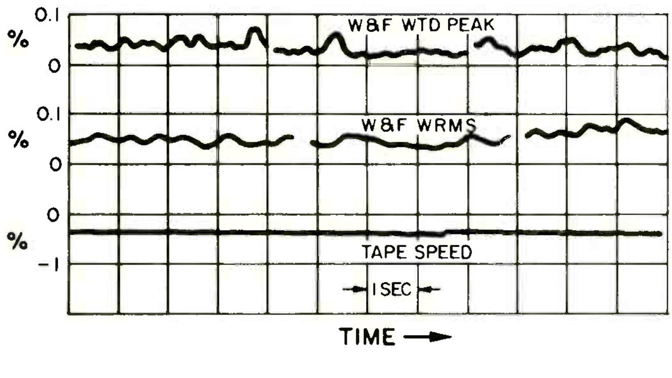


Fig. 7—HDL$_3$ vs. frequency at Dolby level (200 nWb/m) with the Maxell UDXL I, the Sony FeCr, and the Scotch Master II tapes.

Referred to D.L., the ratios for three tapes were about 46 to 52 dBA and about 55 to 59 dBA with Dolby. For HDL$_3$ = 3 per cent which was several dB above D.L., the ratios were 55.7 to 59.9 dBA and 64.6 to 67.4 dBA with Dolby. Sony FeCr had the best ratios, and Scotch Master II was slightly better than Maxell UDXL I. Separation from B to A was 40 dB, and crosstalk from B to B of opposite play direction was 80 dB down. Erase of a 1000-Hz tone at D.L. was to at least 78 dB down, excellent performance. After a little diddling, the conclusion was reached that Technics' reference for sensitivities was −8 dB on the meter. This level is shown with a red line on the meter faces, and the instruction book states that this is the overload point for VU meters. This indication, equivalent to about 140 nWb/m, is close to where some cassette recorder meters show zero, but the rationale for classifying this as an overload point is not clear. For this −8-dB indication, mike sensitivity was exactly as specified, 0.25 mV. Line and *AUX* sensitivities were 71 mV, a bit higher than the specified 60 mV. For the same −8-dB indication whether in source or tape monitor, the *Line/AUX* outputs were 0.43 V (0.42 V. spec) with the output level pot at zero reference. With a D.L. indication, the output was 0.6 V. Setting the pot to +8 increased the level to 1.5 V.

The *Mike/AUX* and *Line-in* pots tracked within a dB from +5 down to −40 dB, with even less error above −15 dB. The mike amplifier was linear over a 59-dB range with a +5 maximum-level reference. With the attenuator, an accurate 30 dB, the range was increased to about 75 dB. Line and *AUX* input impedances were about 100 kilohms, and their common output Z was about 3.3 kilohms. The output level control had accurate steps of attenuation of the output signal, and the two sections had excellent tracking. There is no effect on the meter indication with changes in the setting of this pot. The drive to 8-ohm phones was the specified 0.9 V with 0 dB on the meter and the headphones level pot at maximum. Meter scale markings were very accurate over the entire range from −40 to +5 dB, and both meters tracked very closely. The frequency response was down 3 dB at 23 Hz and 22,940 Hz per meter indication. The dynamic response to test tone bursts was very fast, indicating about −1.5 dB with a 10-mS isolated burst and about −5 dB with a 1.5-mS burst. These responses are faster than those shown in the Technics figure and those in the British program meter standard. Decay time was much slower, of course, and appeared to be satisfactory.

Fig. 8—The wow and flutter and tape speeds at the beginning, middle, and end of a C-90 cassette.

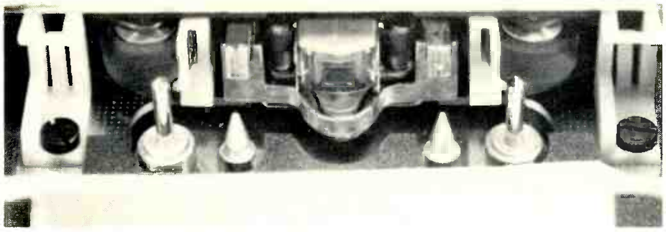


The *Record/Playback* wow and flutter (Fig. 8) varied from a little less than 0.02 per cent to an infrequent 0.07 per cent W rms. The average value was about 0.035 per cent, just under the specified 0.04 per cent, W rms. On a weighted-peak basis, the figures varied from 0.03 to 0.085 per cent, with an average of about 0.06 per cent, just plain outstanding performance. One indication of the superior drive characteristics of the 9900 was that low wow and flutter readings were obtained from a number of cassettes that had been mediocre performers in this regard in other machines. Tape speed with the deck in the *Record* mode was about 1 per cent fast, and *Playback* of the standard tape showed its in-detent speed to be about 0.7 per cent fast. The *Record/Playback* speed change resulting was about 0.3 per cent slow, as shown in the tape speed plot. Speed was consistent throughout the cassette, and there was about 0.1 per cent speed change for a 10-volt change in line power. The playback speed control had a range from −4.8 per cent to +6.8 per cent relative to its detent position (a semitone is a 5.9 per cent change). When examining the internal construction earlier, the speed adjust pot had been noted, and the record speed was easily reset to that desired. The average wind time for a C-60 cassette was 63 seconds. The tension-controlled wind was very smooth and quiet, particularly with some of the cassettes.

Listening and Use Tests

Cassette insertion was very easy, but some care was needed early on to ensure that it was seated all the way as there were a couple cases of getting half-way into *Play* without the cassette being fully into position. Maintenance tasks were more easily performed than on most front-loading machines, but head cleaning did require a little fussing. The switches and controls continued to make favorable impressions throughout the testing. The snap-like positioning of the lever switches and the smoothness of the pots provided mounting evidence of the deck's quality construction. The marker rings could be easily set or rotated as desired, and the pots could be easily turned into or out of detent without shifting the marker ring. Bringing an input pot up to level could be done quickly without needing to look at the ring, quite helpful when you have to watch something else. The output level could be changed the desired amount and easily returned *exactly* to the original setting. The logic-controlled, tape-motion switching performed flawlessly, regardless of all attempts to cause some sort of failure. Changing wind direction was immediate, and the delay from wind to *Play* was very short. There was automatic take-up of any loose loops in the cassette, as inserted. The operation of the timer, memory, pitch control, and tape timer was without any sort of failure in a number of various tests and for several different recording purposes.

The record calibration pots were used occasionally when a change in tape formulation required the adjustment for the difference in record sensitivity. There were many occasions to switch back and forth between preset and variable bias



and EQ, adjusting the pots to match the new tape. For performing tasks such as these, the Technics RS-9900US is superb and not matched by any other cassette system. The inclusion of detents with many of the pots is not only a definite sophistication, but also a practical aid in usage. The instruction book is not lengthy, but it is very well written and illustrated. There are helpful pertinent notes included throughout the text to answer questions that might arise. It is written more for the serious audiophile than for the professional, but the information included would be needed by most owners. A schematic is provided which is detailed for the amplifier, but shows just major blocks for the transport.

For many of the tapes used with the machine, the playback sounded just like the original. With some where the lowest frequencies were slightly higher in level, as shown in the ⅓-octave checks, there was a subtle shift to the bass region. The balance of some tapes sounded slightly better with Dolby NR, perhaps because of the midrange boost observed in the plots. The peak-reading meters were a joy to use, and the decay time appeared right. There were no record clicks detected, but stop clicks could be heard and caused an indication of about −40 dB on the meters. Using the built-in 8-kHz tone alignment of the record head could be done quite rapidly, but earlier tests had shown that greater care produced better alignment. When the cost of the Technics RS-9900US cassette deck is considered, the acquisition might very well be thought of as an investment. With the performance and features of this unit, to say nothing of the 10-year warranty on the record and playback heads, there are many possible returns for its owner. *Howard A. Roberson*

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WILL THE REAL REFERENCE LEVEL PLEASE STAND UP?

Evaluating tape recorders continually emphasizes the problem of selecting, using, and reporting reference levels. It might seem that "0 VU" says it all, but not so. I suspect that most of *Audio*'s readers know that "VU" on a meter face is no guarantee that it meets ANSI Standard C16.5-1954. The standard is quite specific on the required frequency response and the dynamic response to a 0.3 second tone burst. The true VU meter also has an exact level reference, 0 VU for 1 mW in "R" ohms. Because of the relatively low resistance of the meter, isolating resistors are usually needed to keep from loading down the line which is being monitored. For a 600- ohm line, the result is that the meter indication of 0 VU will occur with +4 VU in the line. Take particular note here that the indication on the meter is tied to a *line* level, and that is what the meter was originally designed to measure.

The NAB 1965 standard for reel-to-reel tape recorders indicates an equivalency between a *properly calibrated* VU meter and distortion in the recorded signal. The recommended practice is to adjust the meter for a 0 VU indication 8 dB below the level where HDL_3 (the level of the third harmonic) is 3 per cent at 400 Hz. The NAB 1973 standard for cassettes is expressed differently, giving the reference in tape flux level: 200 nWb/m (nanoWebers per meter) at 400 Hz. The standard states that "this is about 3 to 4 dB below the level for a third harmonic distortion level of 3 per cent." Note that the standards themselves accept higher distortion levels in the cassette format for the same meter indication. The standards cannot be accepted *in toto* as gospel because tape technology has improved greatly, changing the relationships presented in the documents.

Perhaps the 200-nWb/m figure is familiar to you as the flux level for the Dolby reference level for cassette tapes. In the future, *Audio* will give preference to this reference level for both open-reel and cassette recorders. The choice is made for simple, practical reasons. Cassette recorders have absolutely no consistency in calibration of meters, and the significance of a "0 VU" level was usually lost in the modifying comments that had to be attached with half the tests. The alignment tapes used have a reference level of 250 nWb/m, almost 2 dB higher than 200 nWb/m. Once again, explanations were needed to explain where this level would actually appear on a particular meter. The Dolby level reference mark on a cassette recorder's meter consistently shows when the flux level of the tape being played is 200 nWb/m, or how much more or less.

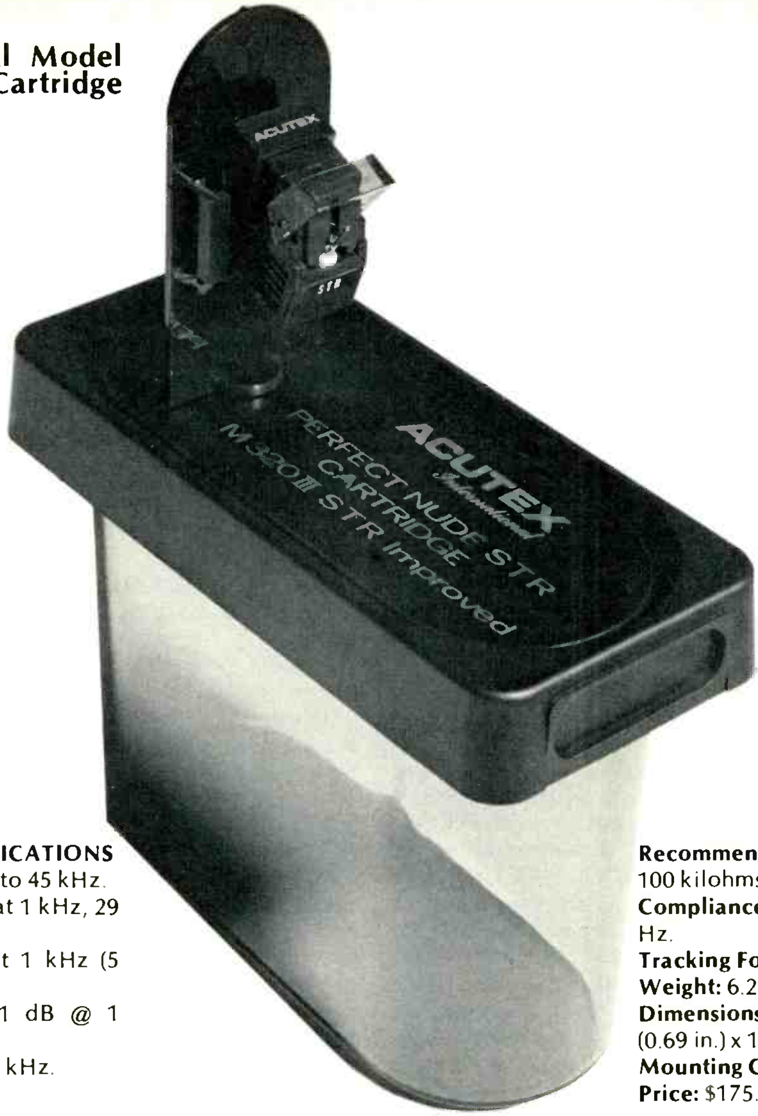
Because the *Record/Playback* performance of the tape recorder is ultimately determined by flux levels, the evaluation of its performance should be tied to this essential property. Swept *Record/Play* responses must be run at the same, known flux levels for accurate assessment of the results and to facilitate comparing one machine to another. Running the same test, but relying on each meter zero as the reference, could result in differences in flux level of several dB. The results might be considerably different, but have little to do with the differences in real performance. These same criteria apply to any tests of distortion, whether as a function of frequency or with changes in record level. The measurement of relative distortion has to be made on the playback signal of course, and the reference level used in the future will be 200 nWb/m at 1000 Hz.

The check of signal-to-noise ratio benefits from using the same 200 nWb/m reference level for one figure, but it is most common to report this ratio relative to $HDL_3 = 3$ per cent. If we measure the output signal, increasing the record level until $HDL_3 = 3$ per cent, and continue recording without a signal, the true S/N ratio can be measured. The approach used by many is to make S/N measurements at a lower level, perhaps meter zero. Then, the record level is increased until the 3 per cent point is reached, and the dB increase in record level is added to the S/N figure obtained earlier. The failure with this method is that there is always some compression at the level causing 3 per cent HDL_3. The real S/N ratio resulting, as measured directly on the playback signal, is perhaps one or two dB less than reported, or perhaps specified.

Another practice, or error, is to measure the 3 per cent HDL_3 point at some frequency other than 1 kHz, such as 400 Hz, which has a lower distortion. Thus, a higher level is measured on the output without any of the weighting normally used for noise measurements. Then, with the signal removed, the record noise is measured with the weighting. This will get higher numbers, but our practice will continue to be using 1 kHz, which is the reference frequency for both ANSI/IEC "A" weighting and CCIR Rec. 468.

Readers may have noticed that some manufacturers specify S/N ratios for Dolby NR as "above 5 kHz." That's another way to get better numbers, but the entire spectrum will be measured with "A" weighting and also with CCIR in the future, which does put more emphasis than "A" weighting on the highest frequencies.

Acutex International Model M320III STR Phono Cartridge



MANUFACTURER'S SPECIFICATIONS
Frequency Response: 20 Hz to 45 kHz.
Channel Separation: 32 dB at 1 kHz, 29 dB at 10 kHz.
Output Voltage: 3.8 mV at 1 kHz (5 cm/sec.).
Channel Balance: Within 1 dB @ 1 kHz.
Impedance: 2.7 kilohms at 1 kHz.
D.c. Resistance: 610 ohms.
Recommended Load Resistance: 30 to 100 kilohms.
Compliance: 42×10^{-6} cm/dyne @ 100 Hz.
Tracking Force Range: 0.8 to 1.8 grams.
Weight: 6.2 grams.
Dimensions: 29 mm (1.14 in.) x 17.5 mm (0.69 in.) x 17 mm (0.67 in.).
Mounting Centers: 12.7 mm (0.5 in.).
Price: $175.00.

It isn't often that a brand-new line of phono cartridges is introduced in this country, especially one which includes four models all based upon a newly patented, improved induced-magnet configuration. The rest of the Acutex International line of pickups includes a Model 315IIIE (which is similar to the 320III but with a bi-radial, nude diamond stylus instead of the "STR" nude diamond found on the 320 which responds to CD-4 frequencies) with a suggested retail price of $135.00 and lower priced Models 312 and 310 which carry suggested retail prices of $85.00 and $65.00 respectively.

All of the aforementioned models feature a new tri-pole induced-magnet design. According to material contained in the patent concerning this new family of cartridges, previous forms of induced-magnet or moving-magnet cartridges have been limited in magnetic efficiency, crosstalk, and distortion characteristics because it has been extremely difficult to locate pole pieces sufficiently close to the armature of the system and thereby reduce the length of the magnetic circuit. Furthermore, the patent description claims that because the conventional armature is supported by a damper member, the fulcrum upon which the armature moves is indefinite in location, making it impossible to concentrate the mass of the vibration system at a single point.

In the M320III STR and other cartridges in this series, a tri-pole armature is attached to the base of the cantilever and is composed of three basic armatures facing in three different directions. One of them fixes the cantilever and increases rigidity, avoiding the possibility of "split vibration" in the vibrating assembly, while the other two armatures pick up the stereo signals and transmit them to the four induction coils.

Physically, the new cartridges are relatively easy to mount in most headshells, with gold-plated terminals provided on the model we tested. We did note that the diameter of these terminals is a bit on the small side, so that in order to obtain good contact between them and the slip-on terminals of the headshell we used (our tests were conducted using the new Empire Model 698 turntable and arm system), we had to pinch the slip-on connectors a bit before applying them to the cartridge terminals. (Editor's Note: While we do not consider this to be a problem of *major* importance, it would make things a good deal more convenient for folks who change cartridges often, like cartridge testers, if all the manufacturers would standardize on terminal size, location, grounding, color coding, etc. This would ultimately make possible a standard one-piece connector between cartridge and tonearm.—E.P.) The entire stylus assembly is removed easily from the cartridge body by gently pulling it downward. A pivoting stylus guard protects the diamond tip during this procedure and also when the cartridge is not in use.

Laboratory Measurements

Our particular sample was a bit "hotter" than specified, delivering 4.3 millivolts at 1 kHz for a recorded velocity of five centimeters per second. Frequency response was just about ruler-flat from 20 Hz to 20 kHz, as illustrated in the graph of Fig. 1. It should be noted that this particular cartridge model has response out to 45,000 Hz and therefore exhibits the usual slight peak in response caused by stylus assembly resonance at a frequency well beyond the usual 20,000-Hz upper limit of our tests. Even more impressive was the separation characteristic which is also shown in Fig. 1. Acutex's claims with respect to improved separation are no idle boast, since we measured a very impressive 33 dB at 1 kHz and an even more remarkable 29 dB (as claimed) at 10 kHz. We used a CBS STR-130 test record for these as well as the frequency response measurements, preferring it over the older STR-100 even though it is necessary to feed the output of the cartridge into a calibrated equalizer-preamp. In our lab we use an All-Test Devices Laboratory Reference preamplifier for that purpose, having found that its RIAA playback characteristic is about the most accurate we have tested.

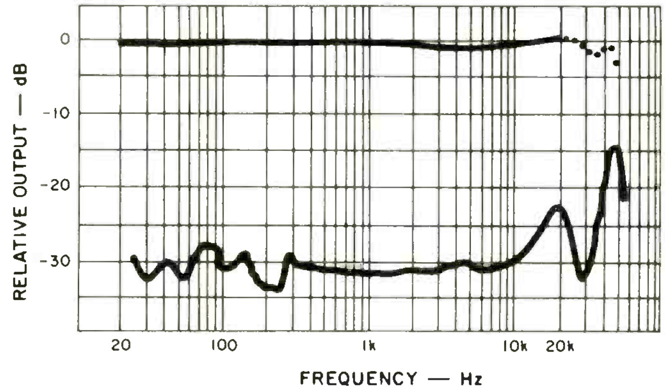


Fig. 1 — The frequency response (upper curve) and crosstalk characteristics of the Acutex M320III cartridge. Points above 20 kHz were plotted using the JVC TRS-1003 CD-4 test record.

Tracking force range is perhaps a bit high by today's standards for a cartridge in this price and performance category, even taking into account the fact that the "STR" shape (designed for tracing CD-4 records) engages more groove wall length and therefore imposes less actual pressure per square area than might at first be supposed. We found that this particular cartridge performed best when tracking force was set to 1.5 grams. Under those operating conditions with anti-skating properly adjusted, we were able to obtain trackability figures of 37 cm/sec. at high frequencies, 40 cm/sec. at mid frequencies, and 30 cm/second at low frequencies. Reducing the tracking force to 1 gram also reduced high frequency trackability to 30 cm/second, as might be expected. We used Shure's TTR-103 test record for these tests.

Not content to accept the stylus description by its unrevealing initials (STR), we delved into the derivation of those letters and discovered (from the people at Acutex) that they stand for "symmetrical tri-radial"—the tip shape of the extended nude diamond tip used in this cartridge. Another description of the stylus tip states that it is an allyptical (not elliptical) shape.

Figure 2 is a 'scope photo of the square-wave reproduction capability of the cartridge and was photographed by applying the output signal directly from the cartridge while it was playing the square-wave test bands of the CBS STR-112 test record.

Use and Listening Tests

Before listening to a variety of musical discs as played with the M320III STR cartridge, we decided to put it through its paces using Shure's newly released Era IV Obstacle Course Record (TTR-115). The first side of this disc consists of musical passages played by individual instruments (orchestral bells, flute, and harp) at incrementally increasing levels. Five levels are provided for each instrument and for the solo selections the M320III STR was able to successfully track all five (quite an accomplishment, incidentally). Side two of the record combines two instruments at increasing levels and is the more difficult to track. In this instance, the cartridge tracked all but the fifth band of the harp and flute combination, and all five of the flute and bell combination tracks. This test record also contains a test for arm-cartridge low-frequency resonance, and for the case of this cartridge mounted in the Empire arm, resonance was measured at 8 Hz, but was not severe enough to cause mistracking or groove hopping. All of these tests were conducted at the previously determined tracking force of 1.5 grams.

Subjectively, the cartridge sounded extremely smooth in response with not the slightest evidence of shrillness or peaked response at the high end, confirming our bench measurements. Interestingly, this cartridge is less susceptible to changes in performance as load resistance is varied than are most. This probably accounts for the broad values of loading resistance given in the published specifications. Between 100 and 150 pF of capacitance (including tonearm wiring) gave the best overall sonic balance to our ears, but variations in this regard also seemed to be less critical than with many other cartridges we have tested. Transient response had already been considered excellent using the orchestral bells test of the TTR-115, but was further confirmed when we played a variety of direct-to-disc records, notably the Sonic Arts **Piano Fireworks** album (SA-LSI) and Umbrella UMB-DD4 (**Big Band Jazz**), both distributed by Audio-Technica. A disc entitled **Warren Smith and Masami Nakagawa**, consisting of flute and percussion selections (RCA/RVC RVL-8502), gave further proof of the cartridge's ability to track complex low- and high-frequency waveforms having sharp transients with little or no evidence of intermodulation distortion. In short, the M320III deserves to join the ranks of those high-end cartridges that set the standard for the rest of the industry.

Leonard Feldman

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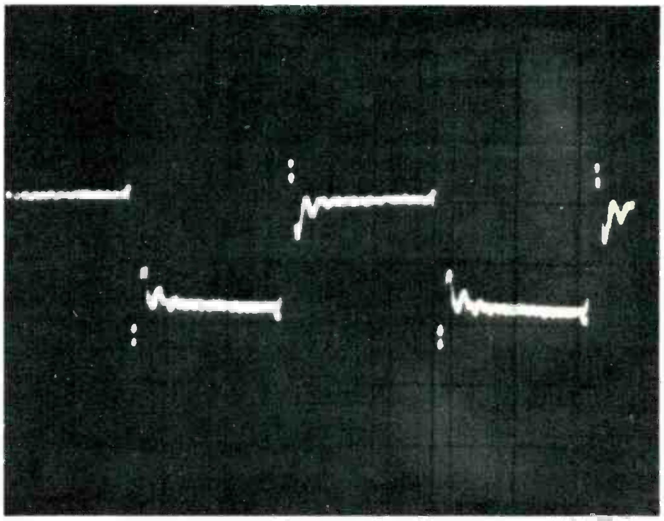
Fig. 2 — Square-wave reproduction (1000 Hz) using the CBS STR-112 test record.



Build a Dolby Noise Reducer

Part II— Kit Building Instructions

This is the second portion of a three-part series on building a Dolby B-type noise reducer and deals with construction of a stereo pair of channels used for alternate encoding and decoding. The next portion of the series will deal with building an additional pair of channels for simultaneous encoding and decoding as for three-head tape machines. While the project was found to be both fun and worthwhile by the editor who built the kit, we do not feel it should be attempted as a first project by the novice. Though no test gear is required, a good set of tools, including a low-wattage, fine-tip soldering iron and a small pair of cutters is essential. Most helpful will be prior experience with kits and familiarity with the resistor and capacitor color codes. A kit of parts is available from Integrex, Inc., whose advertisement appears near the end of this article.—Editor.

Kit Assembly Instructions

In this portion of the article, instructions are given for building two Dolby processing channels for alternate stereo encoding or decoding. Ignore the component locations marked in black, i.e. all component numbers above 200. These are for the version intended for three-head tape decks and provides simultaneous encoding for the *Record* head and decoding of the output of the *Playback* head. Instruction for this section will be given next month.

Main PC Board

A number of PC board pins are supplied with the kit; fit them by inserting them from the foil-track side of the main board, tap down lightly with a small hammer or push in with the flat of a screwdriver so that the shoulder spline is firmly seated into the board. Solder them into place, making certain that **ALL 23** are soldered. The pin positions are as follows:

—Two for the transformer input marked "Vin."
—Four for right and left meter-drive outputs marked "Meters ± L and ± R."
—One for the calibration oscillator marked "Cal. Osc. Out."
—Eleven for the inputs/outputs and common marked "A" through "K."
—Three for the tuner leads marked "Tuner R," "L," and "Screen."
—Two at the right-hand end positions of resistors R13, 113 marked "PR" and "PL."

Close-tolerance components are packed separately. Mount and solder the close-tolerance components first, pushing all components close to the board before soldering. The close-tolerance components to be mounted are: R7, 107 (1%); R34 (2%); R35 (2%); C10, 110 (1%); C11, 111 (1%), C14, 114 (1%); C15, 115 (5%), and C4, 104 (5%).

There are five jumper links to be inserted on the main PC board. Use wire cut off from resistors for these at the positions marked "JL."

Fit the remaining resistors and capacitors EXCEPT R13, 113. Make certain that the electrolytic capacitors are inserted the correct way—the grooved end goes to the plus marking on the board.

Fit the small surface-mount trim pots RV6, 106, RV7, and 107. Fit coils L1, 101. **DO NOT ADJUST L2, 102.**

Fit the transistors, diodes, and ICs. Note the metal insert on the IC regulator and the round indentation on the ICs. The banded end of the diode goes to the plus mark on the board. The two transistors have a flattened "D" shape; the larger flat face, with the sharp corners of the "D" goes toward the two large, gray-bodied capacitors, C4, 104. See the outline drawing to check the locations of the collector, base, and emitter. Note the view is from beneath.

Before fitting the push-button switches, it is advisable to check that they function correctly as they are difficult to remove once soldered. Check mechanical interdependence of AUX, FM, and FM Dolby. Check with battery and bulb or ohmmeter for electrical operation; the switch positions are ganged in sets of three. Take care to push the switches fully into the board and insure that they fit squarely, using the front panel as an alignment guide; **any skew will result in misalignment with the front panel. Solder.**

Insert the "Cal. Tone" switch, taking care that the brass spring is up. Align it using the front panel as a template so that it is in line with the main bank of switches. Solder.

Solder the ends of R13, 113 away from the pin position. Leave the other end, the one toward the pin, standing loose, away from the board, and unsoldered.

Sub PC Board

Components are fitted on the **FOIL** side of the smaller PC board.

Insert the large, up-right trim pots RV3, 103, RV4, 104, and RV5, 105 into the board and solder the back leg. Attach the plastic adjustment inserts into RV3, RV4, and RV5. Adjust all of the trim pots so that they align with the "Cal." holes in the front panel and are square with the front of the sub PC board. Solder and trim remaining legs. The sub PC board should be spaced about 0.09 inch away from the top of the main switch bank to ensure that the "Cal." trim pot centers line up with the front panel holes. Wooden kitchen matches are a convenient spacer for this; the metal shoulders of the adjustment screwdriver are about this distance, but the driver should **not** be used while soldering the sub board in position.

PARTS LIST — INTEGREX NOISE REDUCER
Two-channel alternate encode/decode

RESISTORS		CAPACITORS	
R 1, 101	470K	C 1, 101	10μ
R 2, 102	150K	C 2, 102	10μ
R 3, 103	3.9K	C 3, 103	0.33μ
R 4, 104	4.7K	C 4, 104	10 nF 5% Gray body
R 5, 105	4.7K	C 5, 105	3900 pF Styrene 5%
R 6, 106	2.2K	C 6, 106	3000 pF Styrene, Installed 5%
R 7, 107	3.3K 1%	C 7, 107	2200 pF Styrene 5%
R 8, 108	47K	C 8, 108	10μ
R 9, 109	180	C 9, 109	10μ
R10, 110	270K	C10. 110	5600 pF Styrene 1%
R11, 111	560K	C11, 111	4700 pF Styrene 1%
R12, 112	270K	C12, 112	10μ
R13, 113	330K	C13, 113	10μ
R14, 114	330K	C14, 114	27 nF 1% Styrene
R15, 115	150K	C15, 115	47 nF Mylar
R16, 116	150K	C16, 116	10μ
R17, 117	560	C17, 117	0.1μ
R18	3.9M	C18, 118	0.33μ
R19	3.9M	C19, 119	0.33μ
R20	1.2M	C20, 120	10μ
R21	18K	C21	10μ
R22	680K	C22	1000μ 25V
R23	680K	C23	0.1μ
R24	680K	C24	1 nF Styrene
R25	680K	C25	1 nF Styrene
R26	330K	C26	150 pF
R27	1M	C27	0.047μ
R28	3.9M	C28	0.047μ
R29	10K	C29	220μ 10V
R30	10K	C30	0.1μ
R31	100K	C31	47 nF Square, red plate ceramic
R32, 132	220		
R33, 133	220	C32	47 nF Square, red plate ceramic
R34	180K 2%		
R35	15K 2%	C33, 133	1 nF Disc
R36	82	C34, 134	1 nF Disc

SEMICONDUCTORS		
TR1,	101	ZTX109C
IC1,	101	LM1011A
IC2		LM3900
IC Reg.		1415,131

COILS		
L1,	101	30569
L2,	102	30568 Installed, **DO NOT ADJUST THESE COILS** for the 19-kHz filter.

POTENTIOMETERS	
RV1	50K Log/Reverse Log Dual Control Pot
RV2	50k Log/Log Dual Control Pot
RV3, 103	50K Log Cal. Pot—Large, Upright
RV4, 104	50K Log Cal. Pot—Large, Upright
RV5, 105	5K Log Cal. Pot—Large, Upright
RV6, 106	47K Linear Trim Pot—Small, Surface-Mount
RV7, 107	1K Linear Trim Pot—Small, Surface-Mount
RV8	5k Log/Log Dual Control Pot

MISCELLANEOUS	
SW1, 2, 4, 5, 6	7-position switch bank
SW3	4-pole on-off cal.-tone switch
SW7	Main power switch, DPST
Large PC Board	
Small PC Board	
Phono socket assembly	
23 PC Board Pins (minimum)	
D1, 2, 3, 4	4001, 4002, 4003
D5, 105	1N914, 1N4148, 1S44
D6, 106	1N914, 1N4148, 1S44

Chassis; wood case; front panel with angle mounting brackets; knobs; shield for power supply area; line cord; strain relief; transformer; fuse and holder; meter; self-adhesive foam strip to cushion meter; bulb; 4-lug terminal strip; long sheet-metal screws with stand-offs for power switch; short sheet-metal screws for angle brackets to hold front panel; pan-head screws for main PC board; cadmium-plated screws with nuts for front panel and phono socket board; flat-head screws with nuts for transformer, fuse holder, and meter bracket; long flat-head screw with large washer to secure wood case to chassis; screened wire for connection of main and sub boards; meter and terminal strip connection wire; card for beneath main PC board; plastic inserts for trim pots RV103, 104, and 105 with adjustment screwdriver. Note: Extra hardware, e.g. screws, nuts, PC board pins, will be included.

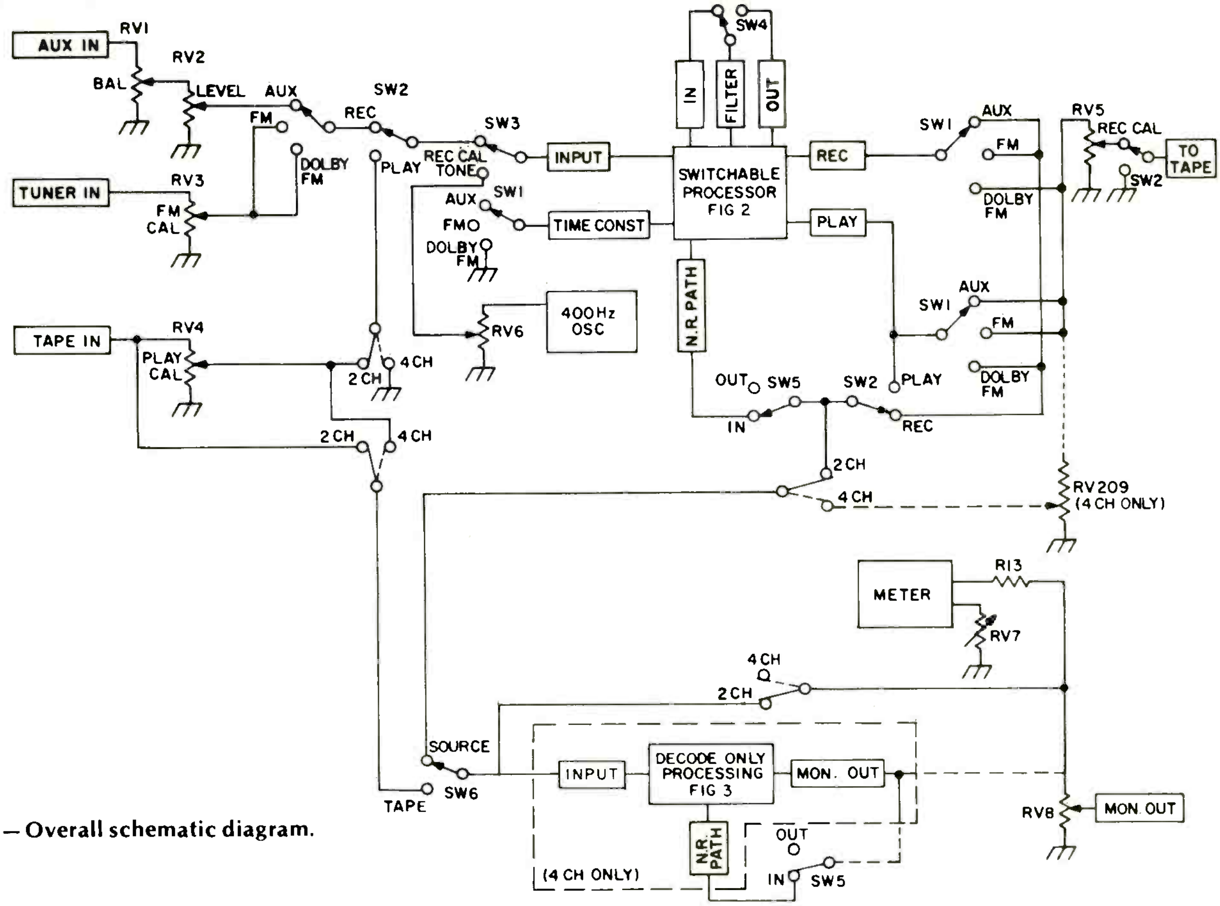


Fig. 1 — Overall schematic diagram.

Position the sub board on the pins of the main bank of switches, check alignment using the front panel as a template and sighting through the "Cal." holes, and solder into position.

Join the areas of the sub board marked "Tuner L and R" to the corresponding points on the main board using the screened twin-lead cable supplied. Ground the **shield only** at the pin marked "screen." The other end floats; do not attach it to the sub board.

Returning to the main board, RV1, RV2, and RV8 can be fitted, using the front panel as a template to align the control pot spindles with the push buttons. Solder the pots with the front panel in position.

Check both boards for solder shorts and/or dry joints.

Crop all leads to avoid touching chassis.

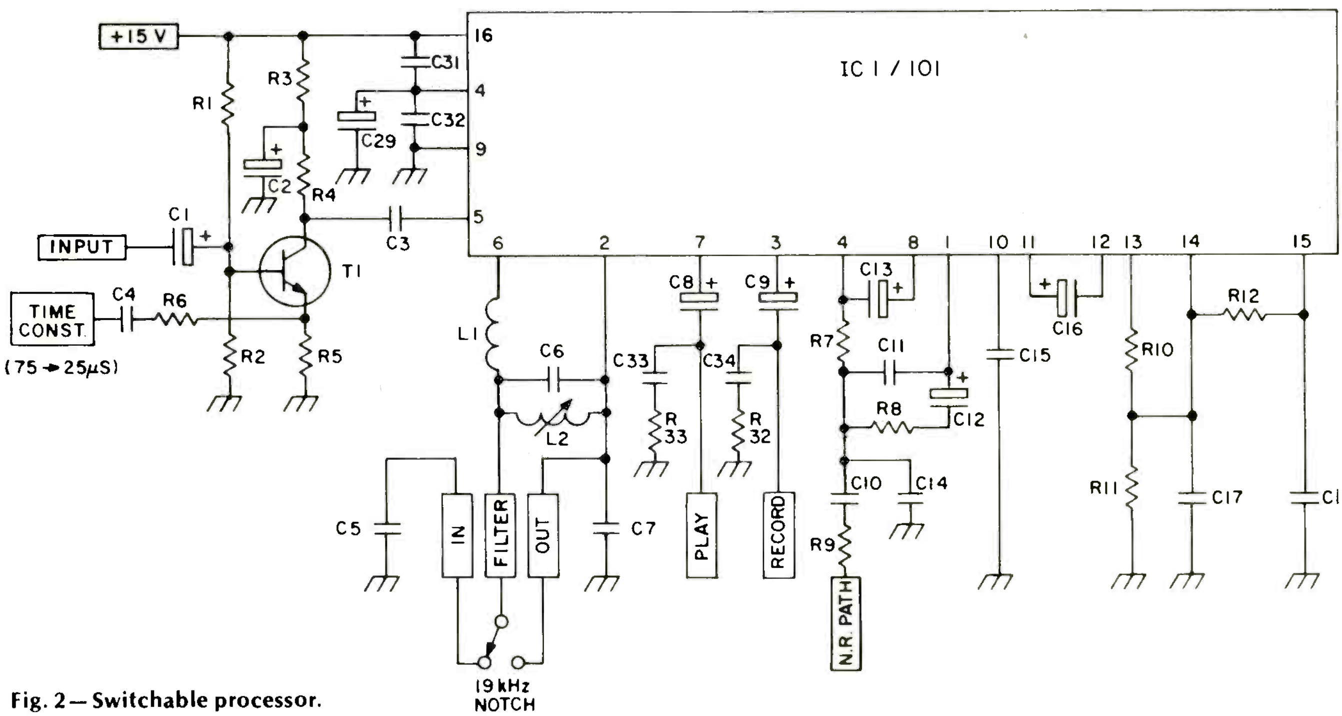


Fig. 2 — Switchable processor.

Insert a thin piece of card between the main board and the chassis, and fix the board in position using the pan-head screws.

Phono Socket Board

Place the self-adhesive label on the phono socket board.

Fit the phono socket board onto the back panel from the inside using the cadmium-plated screws and nuts.

Cut a 5½-inch piece of the solid bare wire.

Thread it through the holes of all the **OUTER RINGS** and to pin "I" on the main PC board, which is marked "Gnd."

Connections between the **CENTERS** of the phono jacks are as follows. Looking at the phono socket board from the PC board side, connections between the centers and the pins on the board are, from left, **UPPER** level, A, D, E, G, and K. Similarly, the connections for the lower-level centers are, from left, B, C, F, H, and J.

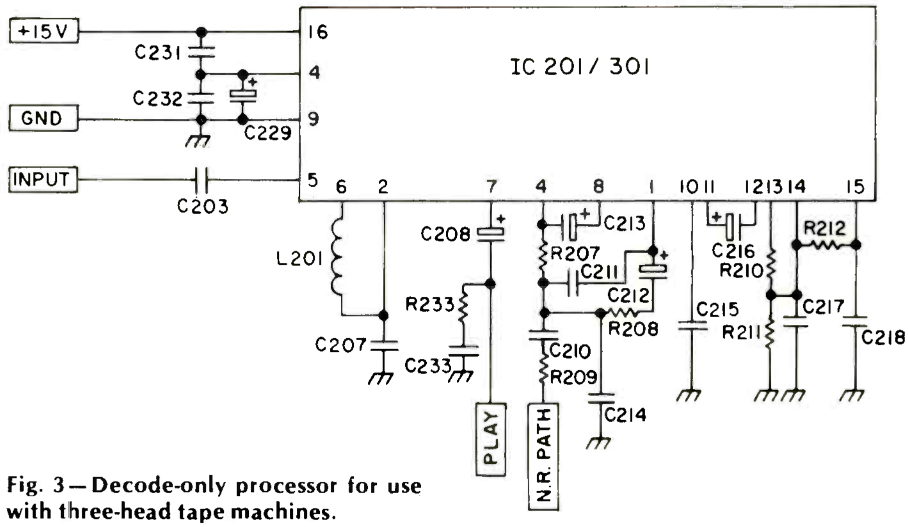


Fig. 3—Decode-only processor for use with three-head tape machines.

Off-Board Assembly

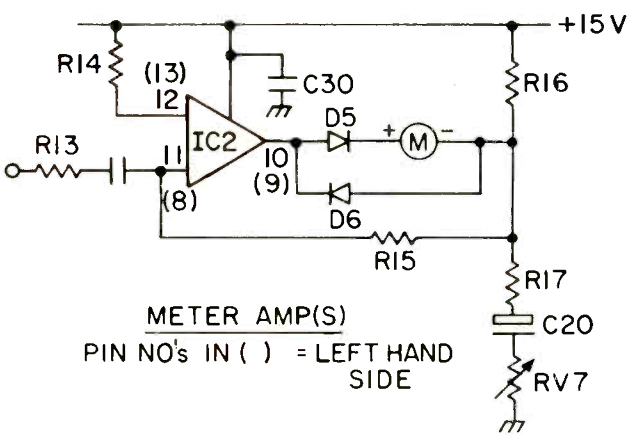
Note the exploded diagram of this area of the kit. Fit in position, using the flat-head screws from the bottom of the chassis:

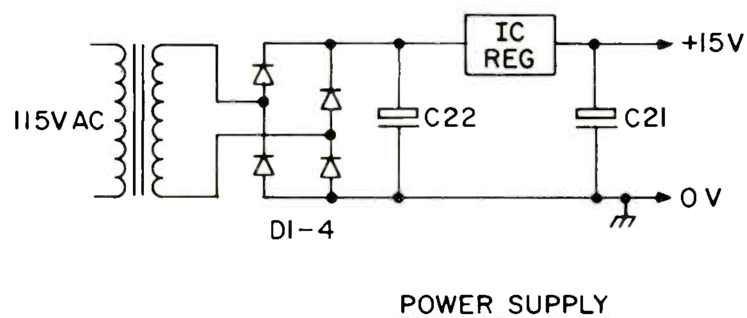
—Transformer; black leads are the primary leads.

—Fuse holder, noting positioning peg.

—Main power switch, using long sheet-metal screws and stand-offs between meter/switch bracket and switch.

—Meter/switch bracket and terminal strip with the terminal attached via hole behind meter opening. It is convenient to hold the nut in position through the meter opening while tightening the screw.





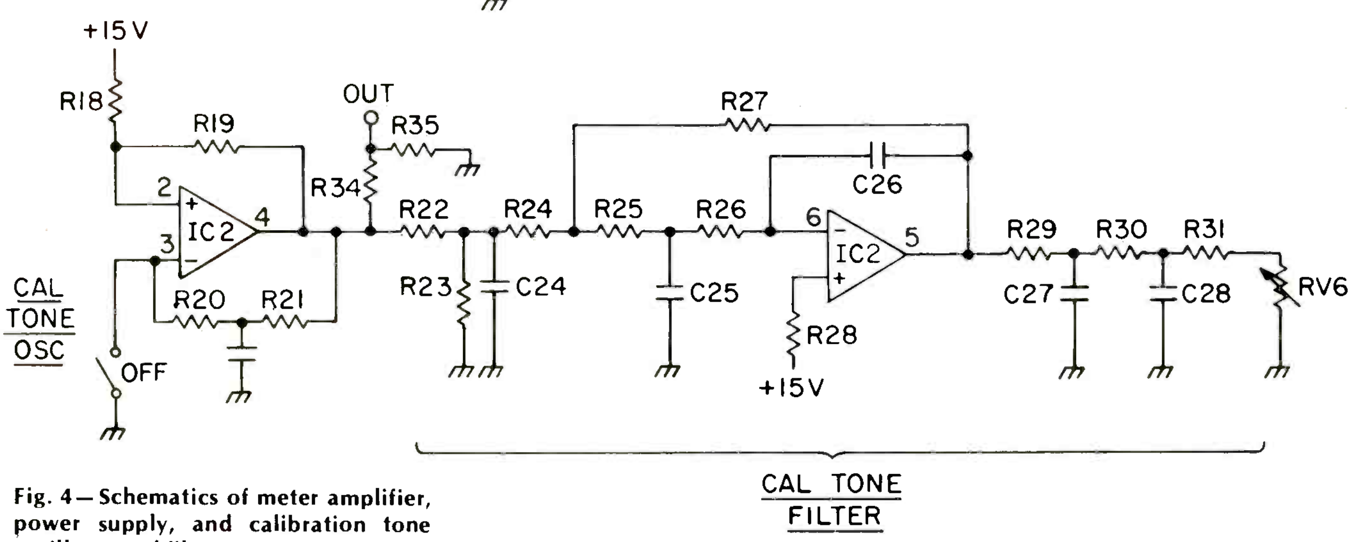


Fig. 4—Schematics of meter amplifier, power supply, and calibration tone oscillator and filter.

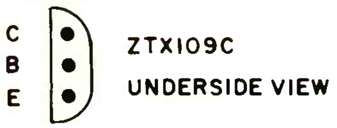


Fig. 5—Identification of leads of ZTX-109C. NOTE: THIS IS THE VIEW FROM UNDERNEATH.

Tape the meter to the front of the bracket using the self-adhesive foam between the meter and the bracket. The foam goes at both top and bottom. Normally the meter will be held in place by the front panel.

Feed the white secondary leads from the transformer forward to the meter/switch bracket and then to the left toward the main PC board. Fix the transformer screen in position, being careful not to nick the secondary leads. Cut the white leads just long enough to be attached to lugs No. 1 and 4 on the terminal strip. Strip and crimp the white leads to lugs nos. 1 and 4 but **DO NOT** solder. Strip both ends of the remaining two white wires and crimp one end of each to terminals nos. 1 and 4. **DO NOT SOLDER.** Do not use lug no. 2, as it is grounded.

Connect and solder the loose ends of the white wire to the Vin points near the upper right-hand corner of the PC board (when viewed from the front).

Cut R36 leads to the proper length and crimp them to lugs nos. 1 and 3.

Tack solder the leads of the grain-of-wheat bulb to lugs nos. 3 and 4. Position the bulb behind the meter.

Solder the three leads at lug no. 1. Solder the two leads at lug no. 3. Solder the three leads to lug no. 4.

Connect and solder the meter terminals to the four meter-drive pins (±M.R. and ±M.L.) near the Vin pins. Note that the terminals on the meters are polarized and are reversed in polarity from side to side.

Remove the transformer screen.

Clip about an inch from the end of one conductor of the a.c. line cord. Strip both ends of this short piece and solder between the front end of the fuse holder and the front-left terminal of the power switch.

Feed the a.c. power cord through the hole in the back panel, strip and solder the shortened end to the back lug of the fuse holder, and strip and solder the longer end to the back-left terminal of the power switch.

Strip and solder the black primary leads of the transformer to the other two lugs of the power switch.

Put the strain relief around the line cord outside the chassis, pull the line cord so that it will be snug between the back of the chassis and internal connections, and insert the strain relief into the back of the chassis using a pair of pliers.

Install fuse into fuse holder.

Install transformer screen, using flathead screws and nuts; screws insert from bottom of chassis. Be careful not to damage transformer secondary wiring.

Place self-adhesive Dolby label on back panel and red warning label on top of transformer screen.

Meter Calibration

The amplifier section of IC2, based on pins 2, 3, and 4, is wired as an unstable multivibrator switching between the 15-volt supply rail and 0 volts with a mark-space ratio of approximately 1 to 1 and a frequency of about 400 Hz. The real voltage swing is slightly less due to saturation voltages but is highly repeatable from one sample to another.

Fig. 6—Wiring of terminal strip.

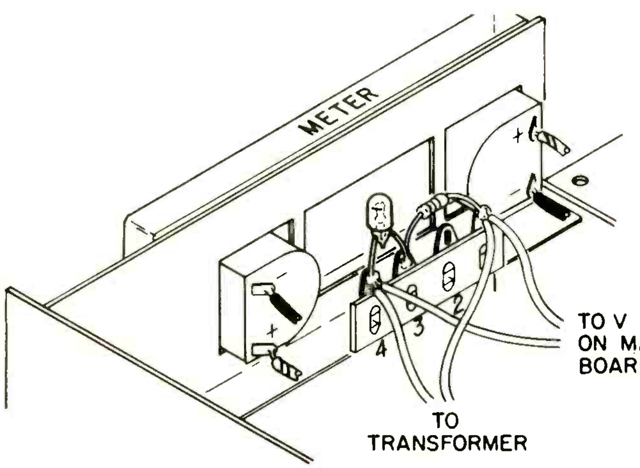
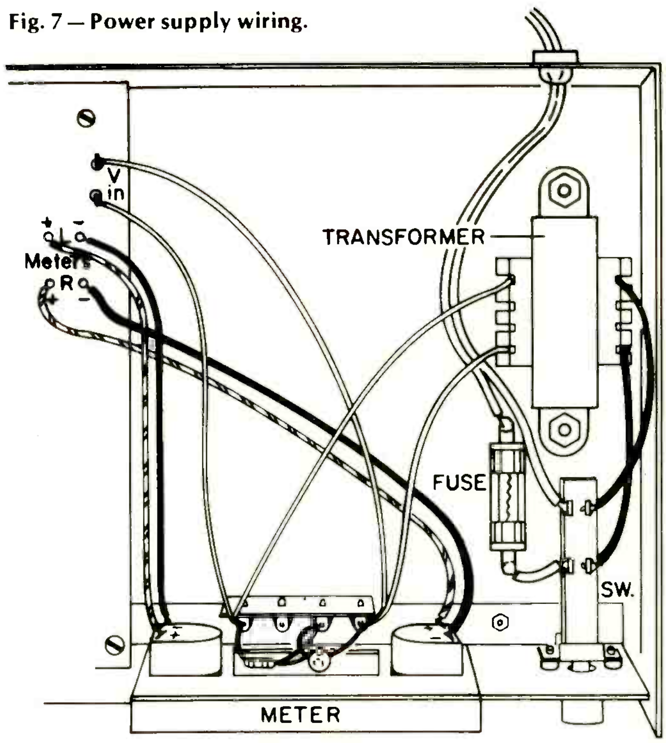


Fig. 7—Power supply wiring.



The calibration procedure is as follows:

Connect the "cal. osc. out" pin located in the back-middle portion of the main PC board to the end of R13 floating away from the board.

—Switch on the power.
—Push the "cal. tone" button in.
—Adjust RV7 for 0 dB on the right-hand meter.
—Switch the power off.
—Disconnect R113 and solder it to the pin PR, cut lead.

—Connect R113 to the "cal. osc. out" pin.

—Repeat steps above for the left channel using RV107.

—Disconnect R113 and solder it to the pin PL, cut lead.

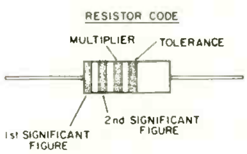
The meters are now calibrated for Dolby level, and they should be calibrated before the simultaneous encode/decode part of the kit is constructed.

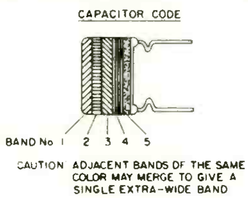
Oscillator Calibration

The square-wave output at pin 4 is low pass filtered by the active filter formed by the amplifier in IC 2 based on pins 1, 5, and 6 to produce a sine wave of less than 1 per cent distortion at 400 Hz. This signal is attenuated by RV 6 and 106 and injected into the circuit when the "cal. tone" button is pressed in.

To set the calibration oscillator ouput level, switch the unit on and push the "cal. tone" button in. DO NOT push Dolby FM or noise reduction while calibrating. Now adjust RV6 and 106 for 0 dB on the right-hand and left-hand meters respectively.

To be continued





RESISTOR COLOR CODE

COLOR	1st + 2nd SIGNIFICANT FIGURES	MULTIPLIER	TOLERANCE
Black	0	1	—
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1000	±3%
Yellow	4	10000	±4%
Green	5	100000	—
Blue	6	1000000	—
Violet	7	10000000	—
Gray	8	100000000	—
White	9	—	—
Gold	—	0.1	±5%
Silver	—	0.01	±10%
No Color	—	—	±20%

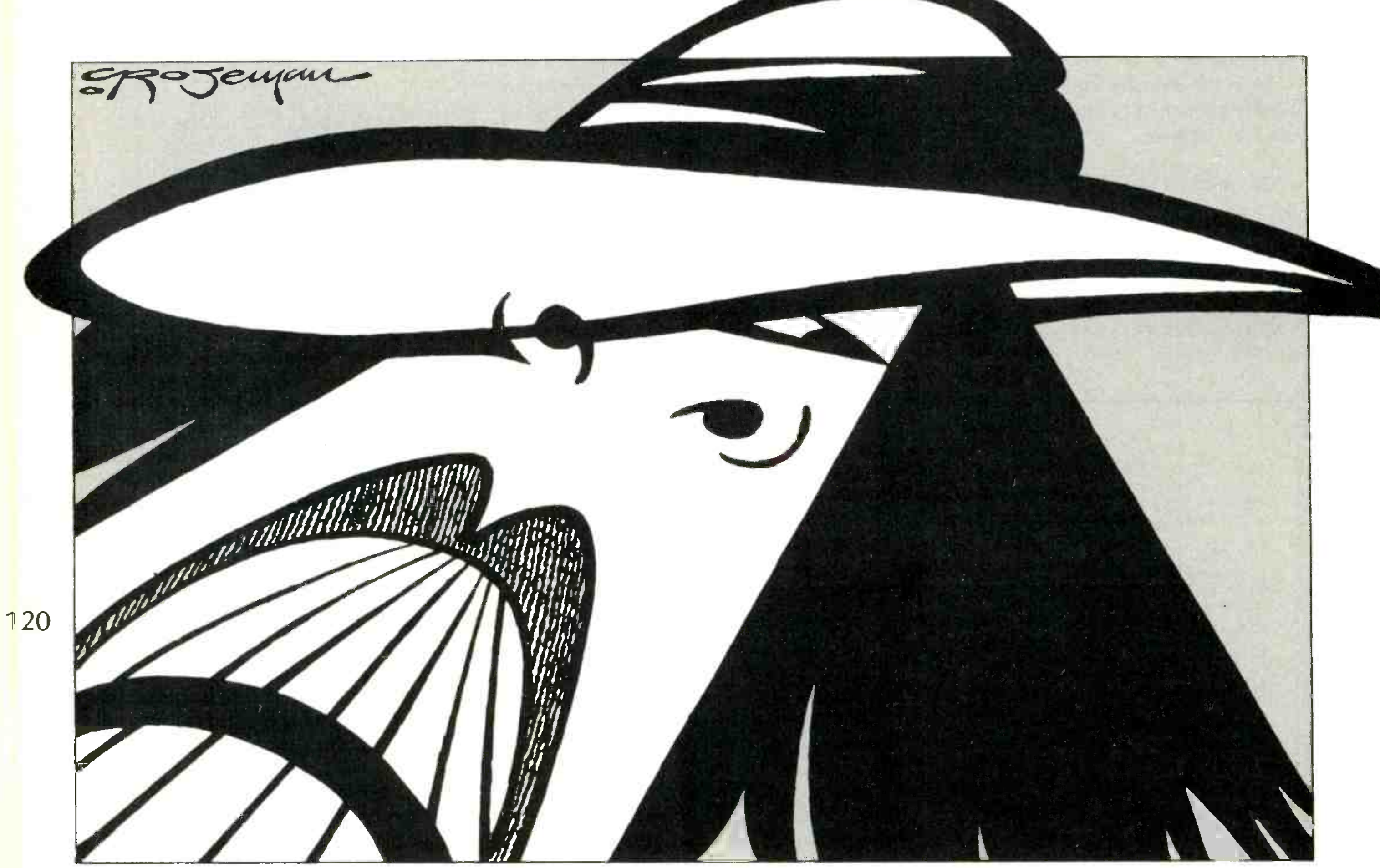
CAPACITOR CODES (CAPACITANCE GIVEN IN PF)

COLOR	DIGIT	MULTIPLIER	TOLERANCE 10 PF OR LESS	TOLERANCE OVER 10 PF
BLACK	0	1	±2.0 pf	±20%
BROWN	1	10	±0.1 pf	±1%
RED	2	100		±2%
ORANGE	3	1000	±0.25 pf	±2.5%
YELLOW	4	10000		
GREEN	5		±0.5 pf	±5%
BLUE	6			
VIOLET	7			
GRAY	8	0.01	±0.25 pf	
WHITE	9	0.1	±1.0 pf	±10%
SILVER				
GOLD				

The column

Michael Tearson

Jon Tiven



George Thorogood and the Destroyers
Rounder 3013, stereo, $6.98.

In an age where contrivance seems the rule, the simplistic blues of George Thorogood has received *mucho* attention, if only for its blatant disregard of current trends. This Beantown guitarist has a three-piece outfit that is neither New Wave, jazz-influenced, nor a triumph of modern technology—if anything, it harkens back to late-sixties West-Coast outfits such as Canned Heat and Creedence Clearwater Revival. He's been kicking up a storm radio-wise with an album that sounds like it was recorded in about the same time it takes to play it; minimal overdubs, a paucity of studio gimmickry, and everything to make it an audiophile's nightmare . . . except for the fact that it's good.

George isn't a great guitar player, but he's got a mean approach that can make up for his lack of technique—his singing is heavy on the personality and light on chops but no matter. Tracks like his version of Bo Diddley's *Ride On Josephine* and Earl Hooker's *You Got To Lose* will remain turntable standards as long as the originals do. The album as a whole is hard to take, for several reasons: The style itself is loaded with more impact if digested in smaller portions, and not every track on the album is as moving as the two mentioned. But what's important is that Thorogood, without drifting too far from the traditional stance of the blues purist, has managed to put out an album that is motivating to the listener who likes to drink his blues straight and commercially successful in a larger sense. People like Muddy Waters, who get help from not only their peers (Little Walter) but also from modern blues popstars (Johnny Winter), have to go some to put out a record like this one. I only hope that when George and his Destroyers find themselves in the recording studio with a producer (this album has none) making tracks for a mass-market record company (Rounder is more of a specialized label), they will be able to continue what they've already started. This debut is a strong one, a surprise from right field as it were, and it would be disappointing to see them swallowed up by the music industry machine. *J.T.*

Sound: C+ Performance: A−

Level Headed: Sweet
Capitol SKAO 11744, stereo, $7.98.
Infinity: Journey
Columbia JC 34912, stereo, $7.98.

Here we have two vastly different groups midway through a career and suddenly taking drastic steps, both having ingested a massive dose of Queen (perhaps *the* group in the vanguard of international rock music) and turning their heads sharply in that direction. In the case of Sweet, it's a tragic loss of a fine hard-rock band changing into a mediocre harmony-pop group, and in the case of Journey we have a directionless crew of instrumentalists turned into a rock entity for the first time in their three-year career.

A brief history of Sweet, née The Sweet: They've been a successful chart-making band overseas for the past five or six years actually had one hit in America at least that long ago and then vanished into thin air without an American record deal. Suddenly they re-emerged on Capitol Records two years ago with a string of three or four hits which were about the most exciting combination of blistering heavy metal and blatant pop cliché-ing to hit the top 40 since the Dave Clark Five; it appeared that they were almost unstoppable. That was, until they left their producers' stable and put out a duff album last year and now we're presented with **Level Headed,** the only positive thing it has going for it being the cover. The record lacks guts, songs, and instrumental arrangements—it has plenty of vocals, which sound severely less impressive than in the past when masked by the wall of rhythm guitars. Surely Brian Connolly doesn't think himself one of the last great tenors—by comparison, Roger Daltrey could drop his good looks and still give him a run for his money. I'm hopeful they will wise up soon, but this is the lowest they've sunk, ever further down than *Reflections* or Coco.

Journey, on the other hand, has learned to rid themselves of their previous boring incarnations and have emerged anew as a wholly different animal. They may not be the greatest thing since sliced Graham Parker, but with the help of Queen's producer Roy Thomas Baker and a new lead singer they could almost pass for Queen with facial hair. Oh, they may be Americans and have a lot of that still left in them, but in time it will pass. At least they've rid themselves of horrendous neo-Mahavishnu excursions, lyrics which would make any English teacher's arm-pit hair stand on end, and a hopeless musical mishmash of non-ideas. They aren't home free, but they do have potential. *J.T.*

Sweet

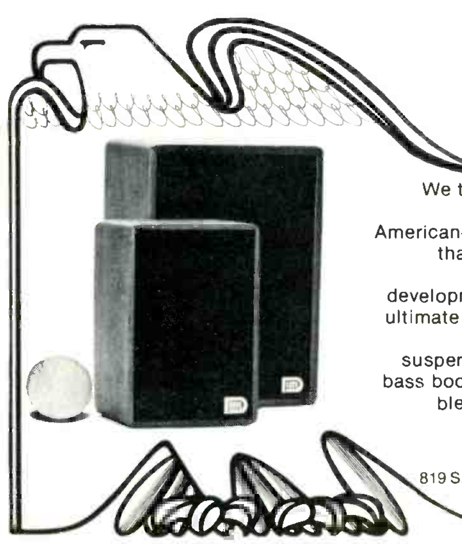
Sound: B	Performance: D

Journey

Sound: A—	Performance: B

One World: John Martyn
Island ILPS 9492, stereo, $7.98.

A mystical atmosphere pervades **One World,** the first new John Martyn



album in several years. With his old friend Chris Blackwell producing, John has turned in one of his finest albums.

There is a pair of absolutely timeless love songs at the opening of the album, *Couldn't Love You More* and the sly *Certain Surprise. Big Muff,* written with legendary reggae and dub music producer Lee Perry, obviously owes a lot to Martyn's time in Jamaica with Perry, playing on sessions. It has a totally distinctive flavor. The title song *One World* is a lovely, sad thing.

A key element to the album's musical success is Steve Winwood who appears on six of the eight tracks, adding a bit of Traffic feel on bass, Moog, and keyboards.

The album is a seductive recording that draws you in effortlessly. It has lovely sound. One number *Small Hours* is almost environmental in nature. Because of its extremely low volume, the small amount of surface noise is unusually amplified, an annoying matter.

John Martyn is a special talent possessed of a personal vision. His music is fiery even when soft. It packs an emotional punch. On **One World** John Martyn is in peak form. *M.T.*

Sound: C Performance: A

Pink Flag: Wire
Harvest ST-11757, stereo, $7.98.

Of all the New Wave groups that this watcher of the scene has come across, Wire seems to be one of the more successful punkers. They are definitely more hard-edged than most and certainly unique—their "get in/get out" approach leaves the listener no time to get bored on the 21 tunes contained on their debut album—but it leaves a few questions about the band.

First off, can they maintain interest on a composition that lasts longer than two minutes (the average track length here)? Are there any instrumentalists of vision in this band, or is this strictly a means to express their group compositions? Lyrically speaking, they aren't exactly the most innovative creatures, but I must say that their sound is somewhere along the lines of a Television or a Voidoids, slightly more Americanized than your average Sex Pistols or Yachts. Their songs are pretty interesting but not really complete, the album is more or less the equivalent of an artist's notebook of ideas that are later worked into full pieces.

This is not to say that the album is not enjoyable—it is. It has some songs which stand up quite well when not listened to as part of an album . . . but if one listens to **Pink Flag** in its entirety one is likely to be more overwhelmed by the sheer volume of ideas rather than the quality of the record. I like Wire, and I sincerely hope that their next record shows them able to create finished pieces which are as interesting as the snippets contained here, but I'd take refined gems rather than the crude stones. *J.T.*

Sound: B Performance: B

The Rutles
Warner Brothers HS 3151, stereo, $8.98.

You remember the Rutles, don't you? The Prefab Four? The legend that will last a lunchtime? You don't? Well, excuse me then while I backtrack.

The Rutles are really the brainchild of Eric Idle, one-time scion of the Monty Python troupe. Idle turned the idea into a TV spectacular including the music contained on this soundtrack album. Composer/producer of the music is Idle's longtime friend and collaborator Neil Innes, fellow former Python and even earlier a kingpin of the loony Bonzo Dog Band. Here Innes presents 14 classic all-time Rutle hits, all of them twisted, bent, and deranged

/rearranged out of a kaleidoscopic array of Beatle notes, riffs, and odd lyrics. Innes is sufficiently deft that his work here simultaneously can sound like the real Beatle item, hold up as uproarious satire or stand as original composition. His pieces range from *Hold My Hand* in a cleaner version of the early Liverpool sound all the way to *Piggy in the Middle*, Innes' brilliant and funny pastiche of *I Am The Walrus*.

Now you remember them. Dirk, Nasty, Stig, and Barry, not to mention Leppo, the legendary "fifth" Rutle. Why, when that other band, the Beatles, broke up someone said that if they hadn't existed, someone would have had to invent them. Now, at last, we've got it both ways. *M.T.*

Sound: B Performance: A

Earth: Jefferson Starship
Grunt BXL1-2575, stereo, $7.98.

The best I can say about **Earth** is that it is Starship's latest. After three excellent albums in a row, I guess they were due for a let down. Not that it's a bad album, it just reminds me inescapably of such lesser Airplane albums as **Bark** and **Long John Silver.**

The sound is the traditional muddy, dense sound that is the group hallmark, but here it's the group that sounds forced and tired doing recycled-sounding material. As I said, **Earth** ain't bad, just average. *M.T.*

Sound: C Performance: C

No Place to Fall: Steve Young
RCA APL1-2510, stereo, $6.98.

Steve Young has been a personal favorite for years. His debut RCA album, last year's **Renegade Picker,** is his finest and a cause for joy at my house. **No Place to Fall** finds the artist evidently not penning too many new tunes these days. There are a couple, but none is as good as his remakes of two of his best early songs, *Montgomery in the Rain* tributing Hank Williams and the oft-recorded *Seven Bridges Road*. Add the Dobie Gray hit *Drift Away*, J.J. Cale's *Same Old Blues* and tastes of Bob Dylan, Steve Goodman, and Townes Van Zandt and you have some good songs, good stuff to work with. However, these performances are flat and the recording dismally muddy. Only Young's spirit and powerful voice are saving graces. *M.T.*

Sound: D+ Performance: C−

European records

John S. Wright

Towards the end of the last roundup I mentioned a comparatively new, but perhaps the fastest growing independent record label, Enigma. I explained their philosophy to be of a purist approach although I had not had time to fully evaluate the releases. Since then I have listened to their work and would refer listeners to a particularly fine recording of **Guitar Music of the Baroque** period played by Carlos Bonell (VAR 1050). In many respects it contains the fine attributes previously praised in the RCA recording of **Spanish Music for Harp.** Both have the same superb sense of spaciousness, that is an instrument being played in a real and suitable acoustic environment rather than closely recorded as in a studio. This not only makes for realism but also for extraordinary ease of listening. I also partly attribute this to the high level of musicality, which is possibly a by-product of the soloist performing in such homogeneous surroundings. Baroque music played by guitar does not sound exciting, but in every respect it is emotionally moving.

If you like a simple crossed-pair configuration, it may be interesting to obtain Enigma's recording of *The Rite of Spring* played by the British National Youth Orchestra (MID 5001). This is a distant recording presenting excellent perspective. The bass end is not exaggerated in the usual manner that befits this work. In this respect many may criticize the recording as being too remote and particularly likely to lose intelligibility if played on low-fi equipment. The dynamic range is actually very wide and, therefore, typically it does not sound loud. The general cutting level is thus low, revealing a more than the ordinary amount of surface noise. A not very forceful interpretation, reflected in a complementary manner by the recording, is that of Bach's *Musical Offering* (Enigma VAR 1044). Also an offering of **16th Century Songs** is made available on VAR 1023 which presents a simply microphoned but close and clean recording, which allows a high cutting level and subsequently a silent surface. Meanwhile Tony Faulkner of Enigma continues research into methods of providing the listener, possessing the taste and accompanying equipment, with material recorded in such a way as not to irritate in the manner so typical of the majority of "commercial" releases.

A group of musicians who share similar views is the *Musica Antiqua*. Even so, if they will forgive me for saying so, their technical acumen is lacking and their press information shows many misnomers in understanding. However, it is the results that count, and although this group has appeared on a number of labels, I would bring your particular attention to their disc entitled **Renaissance Sounds** on Peerless EXP 79. They engaged the services of the BBC Transcription Unit which possibly explains the very open and natural sound quality. (The company apologizes for only having been able to finance the use of a limited amount of equipment.) Again, this record title may not have an initial attraction but take my word that it contains many popular items of the period—the sort that you can never remember the title of. Musically, it is intriguing throughout. Whatever your taste, the interesting and authentic sounds of early instruments contain an enchantment that in itself is creating a renaissance. A motivating member of *Musica Antiqua* assures me that Peerless in the U.S. is also pleased with their sales of an earlier recording entitled **Renaissance Hits** on ORPS 1. I found this too close and dry for my tastes, but if this is doing well, then I predict the later record should do even better. More recently these musicians have become associated with Redifussion records, a couple of which I sampled. I found these clean in a more contrived sense but with space around the instruments.

Continuing the search for unquestioned technical integrity, a record that has received much interest among enthusiastic audiophiles in England has been the work of enthusiast Rod Raw. In essence, he has used his own resources to make cross-pair recordings, mostly of live performances, using Schoeps microphones directly on to his 30-ips converted Revox A77 machine. There is much more to it than this, of course, equalization having been applied in an attempt to overcome the deficiencies of even these superb components. From then on, meticulous attention has been paid to the standards of pressing and cutting, and in all the whole work has been a labor of love. Reactions to the results have been mixed, but always enthusiastic for at least one parameter or another. Entitled **Pieces of Eight** (MIM 2) (Available from Moods in Music Ltd., "New Cottage," Manor Rd., Towersey, Thame, Oxon, England, for $10.00 U.S. via airmail), my criticism lies in the extreme low-frequency phasing which I suspect to be the difficulty, even with compensation, of getting a Revox tape head to operate at such a tape speed. However, the ability to detect this on wide range equipment throws doubt on the common bass sub-woofer argument, since it is demonstrably obvious that phase and arrival time difference, even at subsonic frequencies, are important and that only separate, full-range, stereo speakers can reproduce this vital information.

All this leads me to pontificate as to why it should be that I am allowed to pass judgment on the technical merits of the numerous records made available to me. There is no perfect system, there are no perfect ears, and there is no international standard for good taste. Therefore it must be left to the reader with regard to this column to determine whether my tastes complement or contradict his own. It must by now be clear that wherever possible, I personally prefer records to be uncontrived but, nevertheless, I am more than willing to concede that some brilliant engineering in other directions can result in software ideally suited for the domestic environment where the listener is denied its visual counterpart.

With regard to the review equipment, this conventionally consists of an Ortofon MC-20 cartridge with its electronic preamplifier; although I do change pickups often since reviewing these is also an active pastime. The cartridge is mounted in an SME Series III tonearm fitted to a Technics turntable. This is installed into a reinforced base which is hung in a metal frame weighted to the floor by hundreds of records. Thus structural acoustic feedback is unlikely. Apart from many other incidental items of anciliary equipment, the main amplification consists of two Luxman M4000 power amplifiers feeding four IMF Electronics Reference Standard Professional Monitor Mk. IV loudspeakers. Four loudspeakers . . . ? Some members of this speaker company, of which I am one, have long since been involved in a project with the British National Research Development Corporation in the development of a system of recording known as *Ambisonics*. Subsequently this has become of major importance, with the BBC having commenced occasional but increasing broadcasts in a format now known as *HJ*, together with the understanding of independent broadcast stations as well as many in Europe and Scandinavia. (This is not to say that a number of record companies are not without interest, and we especially appreciate the collaboration of Nippon Columbia.) The reason then for the four loudspeakers is to playback this material. This venture is very much a "back to basics" approach and should not be confused with the quadraphonics, being more concerned with the reproduction of natural ambience. I explain this not merely for information, but so that I may keep you informed as to any such records that may be available in the future. However, in the meantime, the reader can be assured that records reviewed in these articles are replayed strictly in the conventional stereophonic mode, typically with all tone controls flat and all filters out!

Continuing then with naturalism, it is hardly surprising that Philips heads my list of fine classical records. This quarter, quite outstanding is the release by Alfred Brendel (again) playing Shubert *Impromtus*. There is so little I need say about this disc except that it is just superb in every respect, with modulated tape hiss only just discernable to the super critical. I have admired Brendel's Beethoven for many years, and I admire this Schubert more. Staying with superb piano performances, but if not superb sound, CBS has issued a double album of Glenn Gould playing *The English Suites* by Bach on 79208 (2). His dexterity is as outstanding as ever, Gould being to Bach what Berman has become to Liszt. Interestingly the recording quality is of a similar honky type to that of past recordings of Gould. I can find no reason for this except that it may be yet another idiosyncrasy of this man's unusual approach to Bach. In fact, in the same month we have an opportunity to compare both the earlier performance and recording quality on a second reissue of his now famous interpretation of the *Goldberg Variations* (61571 mono). The previous reissue (72692) was also mono but presented in psuedo-stereo (which effect I did not particulary like), but it did and does sound clearer than this latest release which has a poorer surface accompanied by a comparatively low cutting level, considering the restricted dynamic range. Be this as it may, although nobody is going to buy these records for their sound quality, if they are Gould/Bach fanatics, nothing should deter them from obtaining either, or both, of these recordings.

Having just mentioned Lazar Berman, CBS has issued an **In Recital** record (76612) which for this label is recorded in a quite superior manner. The well-known program demonstrates Berman's outstanding confidence in his own performance and many of the works provide the opportunity for Horowitz-type fireworks.

Also on the CBS label is more virtuoso playing. A selection of popular impresario violin pieces is performed by John Georgiadis (accompanied by Susan Georgiadis) and named **Moto**

Perpetuo (73690). This is well recorded with a good balance where the violin does not predominate over the piano, and yet a sense of position is maintained within a resonant setting. Being bright but not brash, much of this recording contains an intrinsic sense of humor.

Returning to Bach, an important release on the RCA label is a box set of music with Julian Bream playing lute and guitar accompanied by George Malcolm (harpsichord) on RL 42378 (2). A selection of suitable music includes the *Lute Suites Nos. 1 & 2, Trio Sonatas Nos. 1 & 5* with another two incidental pieces. The sensitive performance is not complemented to my tastes by the approach of the recording engineer, but I must concede that it is likely to gain the approval of the majority of the record-buying public. The microphone position for the guitar is close providing an ultra-clinical sound which permits a high cutting level, thus lowering the background noise to a level approaching imperceptibility. Argo (ZRG 873) has also continued their series of Richard Hickox conducting Bach choral music, this time the *Mass in F,* BMV 233, and *in A,* BMV 234. This precedes the earlier recording of *Masses in G* and *G minor* previously referred (ZRG 829), which was technically not as immediate as this new recording which retains some sense of airiness despite the use of solo spot microphoning. Bach in particular has an uncanny way of living through such subterfuges. . . .

Another particular piece of music, which through the generations has lived through many treatments, is that of the Paganini *Theme* from his *Caprice in A Minor, No. 24.* This is currently undergoing yet another revival in the guise of variations by Andrew Lloyd-Weber. Entitled simply **Variations,** this is released by MCA records on MCF 2824. It is quite apart from the normal type of music reviewed here, straddling the gap between rock and classical by the ingenious use of both conventional acoustic instruments together with various electronic paraphernalia. This is one of those works that can only exist in the recorded format, having been written with this medium in mind. Both musically and technically, however, I consider it to be light years ahead of many such competitive enterprises, and it is being justly rewarded for its catchy rhythms by not only getting onto the "charts," but also in being recognized by the serious music fraternity. The standard of excellence is also proven from the technical standpoint, the sound being crisp, clean, and extended in both the dynamic and frequency range.

Two recordings of Walton's *Belshazzar's Feast* have recently appeared, one on the Decca label with Sir Georg Solti (SET 618) and the other on RCA (RL 25105). My attention is focused in all respects on the latter, which was recorded at the Usher Hall, Edinburgh, and conducted by Sir Alexander Gibson. In many respects the recording bares close similarities to that of their **Spirit of England,** being laid back behind the speakers with a wide dynamic frequency range. Indeed these are both engineered by Brian Couzens and possess a sense of perspective that *naturally* accentuates the soloist, but could benefit from a better pressing quality than the review sample.

Continuing with vocal recordings, Richard Bonynge conducts the National Philharmonic Orchestra in a selection of well-loved operatic duets sung by Joan Sutherland and Luciano Pavarotti on SXL 6828. Engineered by Kenneth Wilkinson and James Lock, it is a typical Decca stereo-stage presentation. For those who prefer this type of pinpoint imagery, I would also draw their attention to the same orchestra, conductor, and engineer in works by

Massenet on SXL 6827. Those who enjoyed the earlier recording of **Les Patineurs** (SXL 6812) that I have consistently recommended should also enjoy this release, which is just as slick.

I also gave a rave review to the recordings of Rostropovitch conducting the **Tchaikovsky Six Symphonies** (SLS 5099). Now we have a selection of works conducted by him, all standards such as Moussorgsky's *Night on a Bare Mountain,* this time engineered by Paul Vavasseur on EMI ASD 3421. This is typically more distant and light in quality in comparison with the Tchaikovsky (engineer Neville Boyling), and this is less immediately spectacular, being comparatively lacking in bass. However the bonus is better upper low-frequency definition and high transients. Musically Rostropovitch presents these works in the same pacey and onward-going manner.

Comparatively a lush performance is that of Beethoven's *Symphony No. 3, Eroica* coupled to the *Egmont* Overture by the London Symphony Orchestra conductor Eugen Jochum (EMI ASD 3376). One of my favorite teams of director/engineer, Parker and Bishop, has filled the stereo stage in their own inimitable manner providing a good frequency range and balance with no undue emphasis on any particular sonic parameter. Avoiding the hardness of most competitive editions, a high degree of detail is maintained with a sensible amount of reverberation in the mix.

Two recordings have also recently been issued of Ravel's *Bolero,* one coupled with *La Mer* and *Prelude a l'apres-midi d'un faune* on the EMI label and the other coupled entirely to popular works by the same composer, in particular *La Valse.* This appears on the Philips label (9500 314) and is with the Concertgebouw Orchestra conducted by Bernard Haitink. To me this is by far the most preferable of all *Bolero* recordings so far reviewed, and for those who have similar tastes I have no hesitation in whole-heartedly recommending it not merely for the music, but especially for the sound. It is not quite as distant as some other Concertgebouw recordings, being more spectacular (particularly the bass drum) yet still within the confines of commercial good taste.

Back in 1968 EMI released a record of Mahler's *Des Knaben Wunderhorn* with Fischer-Dieskau, Schwarzkopf, et al., and throughout the years I have yet to find a better recording, let alone comparable performance. Now we have a firm competitor in a new release with John Shirley-Quirk and Jessey Norman with the Concertgebouw Orchestra, conducted by Bernard Haitink (Philips 9500 316). While the brass is not as forward as the older EMI version and the order of interpretation somewhat revised, this new record is good with respect to having warm and extended low frequencies, yet retaining distinct pronunciation.

Philip Jones Brass Ensemble fans should note that the group's new release consists of a selection, both ancient and modern, of fanfare-type music. (In fact, the disc is entitled **Fanfare** on Argo ZRG 870.) The consistently high standard of crispness coupled with ambience is maintained as with all their other albums. Although much of this music is somewhat obscure, it is nearly all quite gripping.

Three Vivaldi items deserve mention. Staying with the Argo label, this time with the Academy of St. Martin-in-the-Fields directed by Neville Marriner, we have the **Concerti for Wind and Strings** on ZRG 839. This is rather like the early Argo days for the untiring presentation of smoothness and ambience. In fact, this observation reminds me to mention that Argo has reissued their 1960s recordings of the

Rossini String Sonatas (and the *Donizetti String Quartet in D)* on ZK 26/27. They are just as fresh as the day they were made and will be a lesson to those who consider that it is the media and not just the equipment that has improved.

We have a modern recording and interpretation of the Vivaldi *Magnifica* and *Gloria* from EMI on ASD 3148 which is full bodied yet detailed, being only marginally sibilant in places. Philips Vivaldi contribution lies in the *Oboe Concertos in A minor* P42; *C*, P44; *D*, P187; *F*, P306, and also *F*, P457—all on one disc (9500 299)! Performed in the *I Musici* series with Heinz Holliger soloist, this is more of a studio approach, being clean and crisp with slight over-emphasis of the soloist, but nevertheless a record of exceptionally high standard.

Returning, where we came in, with records of a purist nature, two such are both "musical wallpaper" presentations. Again, I highlight a recording of Neville Marriner with the Academy this time on Philips playing the Haydn *Symphonies Nos. 22 "The Philosopher"* and *No. 55 "The Schoolmaster"* (9500 198). Despite the apparent contradiction in terms, this is an impressively simple recording, being essentially relaxing, yet retaining the pedantic nature of the music. Equally relaxing is a Haitink/Concertgebouw recording of Brahms *Serenade No. 1* (9500 322) which contains the typical ambience associated with this combination, but with more low-frequency information than usual. It implies a sense that we are "looking down" upon the performance, and although probably unimpressive to an uninitiated listener, this ideally suits the music.

And now for sheer fun . . . Saint-Saëns **Carnival of the Animals** (EMI ASD 3448), featuring Michael Beroff and Jean-Phillipe Collard (pianos), exploits the humor of this music to the extreme—and indeed the tempo. Listen particularly for those animals known as "pianists." How difficult it must be for such professionals to play just out of the correct rhythm in their imitation of amateurs. The engineering by Sergé Remy is not over-resonant but correctly clean and close for the attitude of the production, while the attack and sparkle, noticeable on the high-frequency end of the percussion, makes some fine demonstration material. In all, I have not heard such a performance since Whittemore & Lowe recorded it for EMI back in 1960. From whatever view point, this new record is eminently enjoyable—and surely that is the name of the game!

Carmen McRae at the Great American Music Hall
Blue Note BN-LA709-H2, stereo, $7.98.
Carmen McRae Alone
Catalyst 7904, stereo, $6.98.

Carmen McRae, heiress apparent to Billie Holiday, has never had mass appeal, yet she is acknowledged by musicians and critics as a major interpretator of American song, a gifted actress, plus skilled musician and craftsman in handling a lyric.

Like Billie Holiday, she has the ability to get inside a song and communicate the guts out of it, and she does this with consummate skill on Catalyst's **Carmen McRae Alone**, recorded "live" in November of 1973 at a Tokyo club called the "Dug." Accompanying herself at the piano, McRae is brilliantly articulate on songs like *As Time Goes By, I Could Have Told You So, More Than You Know, I Can't Escape From You, Suppertime, But Not For Me,* and *Please Be Kind.* She brings a great sense of intimacy to each of them and is remarkably sensitive to their varying moods.

Not only is McRae a perceptive song stylist, she is a master of jazz phrasing. Like fine jazz singers, she sings as an instrumentalist plays. In terms of jazz instruments, McRae can be described as a tenor sax, her vocals have a depth, fluidity, and resonance that are uniquely strong. In the Blue Note double-set taped live at San Francisco's Great American Music Hall, McRae's jazz side is to the fore; as accompanied by an excellent trio, she swoops and dives around every word. Carefully chosen songs such as *Time After Time, Old Folks, Star Eyes,* and *Green Dolphin Street* are read with a beautiful clarity and sympathy.

There are a few moments of strain and excessive ornamentation as on *Drunk on San Francisco* and *Taint Nobody's Business,* but McRae's overall batting average is pretty high as she presents 22 songs that reveal the full extent of her art. The emotional depth, wit, imagination, and vocal resources that she employs in interpreting each melody are impressive.

Dizzy Gillespie appears on several tracks with Carmen and is in wonderful form; his muted trumpet obbligatos offering wry, sardonic comments to McRae's lyrics.

Many live performances suffer from poor recording balance, but not in the case of these McRae albums; the sonics captured at both Tokyo's "Dug" and San Francisco's Great American Music Hall are excellent. *John Lissner*

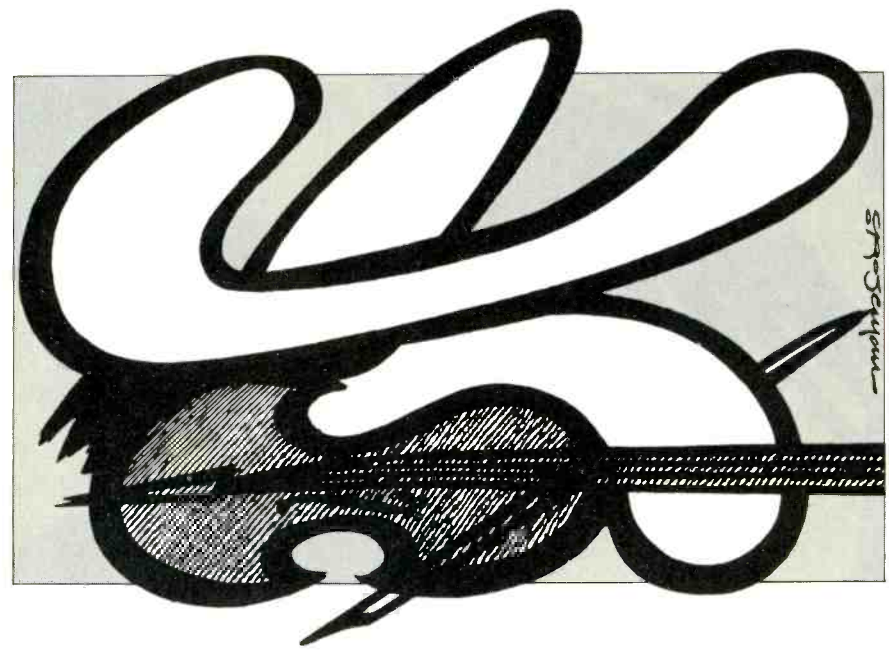
Alone

Sound: A— Performance A:

Great American Music Hall

Sound: A— Performance: A—

Folk bag



Old-Time Fiddler's Repertory
University of Missouri Press, mono, two records, $10.50.

Traditional Midwestern fiddle music is a rare commodity on records, so this collection of 41 field recordings (most of them dating from 1949 to '51) would be significant even if the music wasn't so enjoyably frisky. Nevertheless, there are two major flaws to the set, neither of which makes it any less indispensable, though they do detract somewhat from its documentary and entertainment value.

For one thing, there are five fiddlers represented here, four Missourians and a Nebraskan. Two of the Missouri fiddlers, Cyril Stinnett and George Helton, have only one track each, while Tony Gilmore has three and Bill Driver is identified as the fiddler on six. (However, issue 42 of the scholarly JEMF Quarterly claims the fiddler on *Iberia Breakdown* is not Driver, but Fred Doxstadder; it *does* sound like a different performer on this cut than on Driver's other selections. On the other hand, *Hell In Texas* is credited to Bob Walters on the cover, but to Driver on the record; the latter seems more likely.) This leaves no less than 29 cuts for the one remaining artist, a professional radio fiddler from Nebraska called Uncle Bob Walters. To be certain, Walters is more than worthy of the exposure, though not necessarily at the expense of Stinnett and Helton.

R.P. Christeson (who did the original field recordings and compiled both the backup book and this album), delivers bits of information about the tunes and fiddlers—spicing the talk with occasional anecdotes and droll Missouri humor—in a dry Midwestern drawl that adds an atmospheric local color. Nonetheless, his commentary would have been far less intrusive had it been printed in the liner notes (there certainly was space for it between covers).

These carpings aside, **Old-Time Fiddler's Repertory** is a marvelous collection mostly of little-known tunes, ranging from the breakdowns common to traditional fiddling in the Southern U.S., to schottisches, quadrilles, and other set pieces rarely encountered (at least on record) outside the Northeast. Indeed, this observer (whose exposure to Midwestern fiddling has been admittedly flimsy) more closely associates Uncle Bob Walters' smooth yet vigorous style with the Northern U.S. and Eastern Canada (not only on the obvious quadrilles, but also on breakdowns like *Lazy Kate* and *Jump Fingers*) than with the Midwest. It's also worth noting that the melodies of Walters' schottisches are quite clearly European in derivation (in fact, the tune identified here as *Tunes From Home Schottische* is a very popular German rhinelander, though no one I've questioned recognizes this title or recalls the original one), while the skirting 32nd notes he uses for ornamentation on *Thunderbolt Hornpipe* and *Jimmy In the Swamp* seems to derive from Irish tradition. Walters' accompaniment (on piano, piano, and cello or electric guitar and cello) is also in a style more Northern than Southern.

The Missouri fiddlers are, as might be expected geographically, closer to the familiar Southern pattern. Bill Driver jumps into a tune and refuses to let go, Gilmore is distinguished by thick multi-stopping, while Stinnett and Helton are both impressively agile. Gilmore's fiddle rag, *Wait Till You Hear This One, Boy,* is particularly delightful, while Driver makes the most of an *Unnamed Breakdown* (side B, band 7).

The recordings were made on a portable wire machine under less than optimum conditions, at homes, dances, fiddle contests, etc. The accompaniment is very distant on most tracks (though not all), the cello *ostinati* usually little more than a sonic blur (which is unfortunate, as the instrument has too seldom been recorded in this context). The bulk of the fiddling, though, is loud and clear, though several of the original wire recordings show signs of severe wear and tear through the years.

Scratches notwithstanding, I can't imagine anyone with the slightest interest in old-time fiddling living without this collection, which is available from the University of Missouri Press, 107 Swallow Hall, Columbia, Mo. 65201. *Tom Bingham*

Sound: C Performance: B+ to A

Endangered Species: Hamiet Bluiett
India Navigation IN 1025, stereo, $6.98.

This boldly uncompromising and thoroughly engrossing record marks ex-Mingus baritone saxophonist Hamiet Bluiett's debut as a leader. He is joined by former Paul Butterfield drummer Phillip Wilson, up-and-coming trumpeter Olu Dara, and two seasoned veterans of the jazz avant-garde, bassist Junie Booth and auxiliary percussionist Jumma Santos. Although Bluiett wrote all four of the album's compositions and is (presumably) responsible for the music's direction, all five musicians share the spotlight on an equal basis.

The opening *Between the Rain Drops* is an introspective, almost grave quasi-ballad which never assumes a regular tempo or recurring rhythm pattern. Bluiett's solo is persuasively gentle, but Dara is considerably angrier, biting and growling into his horn. It's a stunning piece, which continually draws the listener into its stark shifts of temperament.

Sobre una Nube is the only up-tempo cut, built around a swinging, rocking modal bass line over a pseudo-Latin beat. Bluiett's convoluted lines are his most furious on the album, though Dara seems unsure in which direction to turn. The rhythm becomes progressively looser and freer, until Booth's forward bass motion is all that's left of the original pulse.

The album's major opus is the 20-minute *The Other Side of the World*, an East-meets-West exploration highly influenced by Indonesian gamelan music. The dignified theme is stated by Dara and Bluiett (on flute) over a sober bass pattern that sounds like a backdrop for a coronation cortege. Santos, on the marimba-like Javanese balafon, adds a hint of perky playfulness to the increasingly demanding collective interaction. Dara's brassy atonalism is more firmly under control; listen also to Wilson's arhythmic accents and fills underneath. Bluiett returns to baritone for an emotional display filled with stern determination and checked hostility.

The album closes with the brief, dedicatory *Ayana Nneke*, an even more somber processional than *The Other Side of the World*. A simple yet supremely eerie tune, *Ayana Nneke* is played without either emotion or elaboration, possessing an inexplicable frigid beauty.

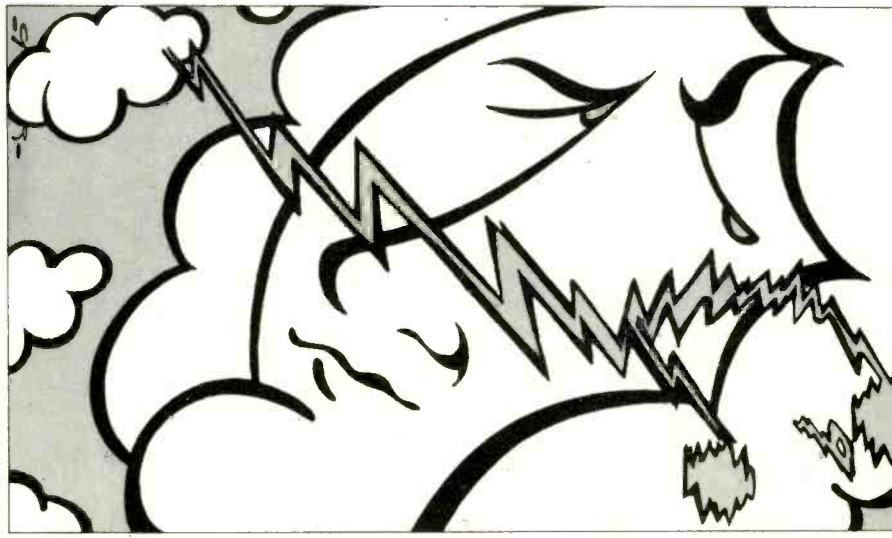
The live recording is more than satisfactory, with a warm edge to Bluiett's baritone and an effective spread of the variegated percussive colors. Both Bluiett and, to a greater extent, Dara have a tendency to wander away from the mikes, which can be quite disconcerting at times, though the engineer can hardly be faulted for the musicians' idiosyncracies.

Available from India Navigation Company, P. O. Box 559, Nyack, NY 10960. *Tom Bingham*

Sound: B Performance: A

Classical reviews

Edward Tatnall Canby



Portrait of P.D.Q. Bach. The New York Pick-Up Ensemble, etc., Peter Schickele. **Vanguard VSD 79399,** stereo, $7.98.

You do have to have a bit of musical experience—not very much—to get the point in these incredible annual all-out farces by the enterprising Peter Schickele and his Vanguard-sponsored team. The recordings are regularly made live (but well planned for disc) at a grand Christmas-season shebang.

Picture of Prof. Schickele on the back, playing P.D.Q. Bach organ music on the piano with—for lack of a pedal board—two hands and one very bare foot. Side 1: *the Missa Hilarious (SN_2O),* including *Yriekay, Gloria, Credo, Sanctus* and *Angus Dei—yes, I said angus,* like a black cow. There's a bargain countertenor and a basso blotto, hand flutes, nose flutes, a corrugahorn, a trombonus interruptus—why go on? The music is what counts.

It is lovely. Schickele, as I've often observed, is a frustrated composer who writes delightful synthetic this and that, right in each style. The pseudo Mass is one of three major items for this year. The *Echo Sonata for Two Unfriendly Groups of Instruments* features limpid fake-17th century music and a recalcitrant echo that will not obey. Cute. Best by far, though, is a genuine tour de force—and an awful Schickelepun—*Eine Kleine Nichtmusik.* (That's what I said—a Little Not- Music.) The original Mozart piece is played straight through by the strings, totally deadpan, not a note out of place, and on top of it, in assorted winds, you hear the most extraordinary and ingenious array of other tunes that fit—from Stephen Foster and Pepsi, to Brahms, Beethoven, Dvořák, Tchaikovsky, Sousa, Grieg, Broadway show tunes, and the *Volga Boat Song*. . . it's amazing! Even Stravinsky's *Petrouchka* gets in, not to mention Strauss's *Til Eulenspiegel.* What NEXT, P.D.Q.?

Charles Ives Complete Works for Solo Piano. Nina Deutsch. **Vox SVBX 5482** (3 discs), stereo, $11.95.

John Kirkpatrick (not Ralph K., the harpsichordist) was the first to rescue the enormous Ives *Concord Sonata* from near-total privacy as one of Ives' numerous "works in progress" that somehow never reached their final format. I heard Kirkpatrick, live, on one of his first tries at the work—he got into the middle, kept going 'round and 'round and couldn't get out; he finally had to stop and apologize though it was Ives himself who no doubt caused the confusion.

It is a most remarkably rambling work of Very Late Romanticism and only now, with a new generation, do we find pianists like Nina Deutsch who can take the thing not only in one solid stride but encompass the assorted variants and options that now are understood to be a prophetic aspect of the whole. "Chance" music, music with assorted options for the performers, music with ad lib semi-controlled improvisation, is all the thing these days.

If you can get through the *Concord Sonata* (one entire LP, both sides) and absorb—or bypass—the elaborate literary allusions, each movement being built around one of the famed Concord residents, Thoreau, Hawthorne, et al., you will find a lot more of the typical Ivesian whimsey and high romance—*Variations on America, the Bells of Yale,* and even a *Waltz Rondo.* Nina Deutsch won't let you down for a moment; she has dedicated much of her life at the piano to this craggy old American. Nor will Vox. Excellent budget-priced recording.

John Powell: Sonata Teutonica, Op. 24 (1913). Roy Hamlin Johnson, piano. **CRI SD 368,** stereo, $6.98.

Here is another member of America's curious musical "lost generation," those of our early 20th-century composers who tried to bring the frenetic, highly emotional ultra-late Romantic style to some sort of local-style expression. I would count among these Charles Ives (in his own craggy way) and also Griffes, and even that borrowed native son, Ernest Bloch. There were plenty more, until WW I suddenly turned the course of music towards jazz and the dryly neo-classic.

John Powell, out of a most unlikely background, Richmond, Virginia, was an important member of this strange generation of Romanticists, and this vast Sonata (with a most unfortunate title for the very eve of WW I!) is very close to the *Concord Sonata* of Ives and to the big piano sonata of Charles Tomlinson Griffes, now boasting several recordings. All of these works had to wait many decades, until a renewed interest in big, Romantic sounds plus quantities of mysticism, transcendentalism, poetic program content, and so on, made the listening once more fashionable and in style. So it is, right now.

You can expect, then, great torrents of piano, sobbing and weeping, as well as singing, and typically, a lot of solid dissonance—though it sounds less so in the Romantic framework. It is that kind of music. A good job (apparently played straight from the manuscript) and as always well recorded by CRI via David Hancock.

Giuliani: Guitar Concertos Op. 36, 70. Pepe Romero; Academy of St. Martin-in-the-Fields, Marriner. **Philips 9500 320,** stereo, $7.95.

These days I tend to eye the latest guitar concerto recording with that "what—*not again!*" look. Too many and too wishy-washy. So I did with this, until I noticed good St. Martin-in-the-Fields, who is one of my own musical saints these days in the person of Neville Marriner. I'll listen to just about anything he proffers, including Pepe Romero and numerous family.

It was a good hunch. Not only are these very pleasantly interesting works, but the guitar, beautifully recorded and balanced against the orchestra, is ultra lively and not at all sentimental, as it can so easily be in lesser "classical" guitar playing. All in all, a record to be recommended to just about any listener.

Tabla Solo. Alla Rakha, with Vasant Rai, tamboura; Collin Walcott, sitar. **Vanguard VSD 79385,** stereo, $7.98.

If you have even a casual interest in the music of India (and plenty of us do today), this record may be your bonanza in several ways. First, it is an East-West collaboration. The usual modest Indian lady who sits in the background zmmm, zmmming on her sitar, is here replaced by a Westerner, out of the University of Indiana and assorted "rock" groups using sitar and tabla. He also produces the disc. And studies with the soloist.

Second, this is unusual in that the entire music is solo (the other instruments simply a background frame), all drum. If you've heard any good tabla player you will know how much can happen within that narrow sonic framework. It does, here.

Even more interesting, though, this drummer intones out loud the curious *dit-dah* syllables, strongly rhythmed, that are used by players to learn the highly complex rhythmic patterns characteristic of this music. Moreover, two whole faces of the double-fold record jacket are given over to the exact notations of these patterns, with the syllables attached—so that even if you do not aspire to play tabla yourself you can here, at last, actually figure out the "sense" of the music in great detail. Many a time I have tried counting out these complex rhythms myself and have lost count just as many times! It isn't easy. Like, say, a pattern of fifteen beats divided into 4, plus 4, plus 4, plus 1½, plus 1½. Just try *that.* It's on this record.

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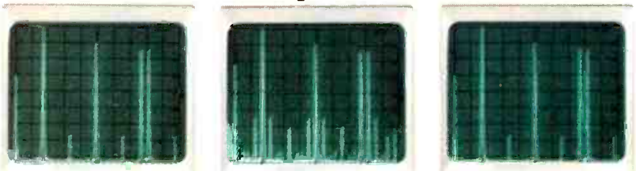
Ultimately

Marantz goes beyond THD to lower TIM (transient intermodulation distortion).

Because TIM doesn't show up on conventional amplifier testing equipment, most manufacturers and their engineers aren't even aware that it exists in their amplifiers. Even if they were, they probably wouldn't know what to do about it.

But because Marantz builds for the music and not just the specs we know how destructive TIM can be to pure sound reproduction. And we've developed a revolutionary new circuit design to eliminate it.

Spectral analysis demonstrates that Marantz conquers TIM distortion.



Test signal (sine and square waves mixed). | Competitive amplifier's output. Note the added distortion products. | Marantz 1180 DC's output is identical to the input test signal.

The reduction of TIM can be the single most important element in making an amplifier sound better. For instance, two amplifiers with identical total harmonic distortion (THD) specifications should sound the same when compared... but the one with low TIM will sound audibly better! That's because TIM adds an unnatural harshness to the music. It's not only detrimental to pure sound reproduction, but it can have an emotional effect that you experience as "listening fatigue."

TIM is caused by an improper design of "negative feedback circuitry," by other manufacturers. Every modern amplifier uses it to lower THD. But *excessive* negative feedback coupled with an insufficient slew rate* can lead to gross internal overloads under the constantly changing transient and sound levels of music. That distortion is TIM.

The gentle slopes of continuous sine wave test signals normally used to test an amplifier simply cannot detect TIM distortion. It requires the type of extremely sophisticated spectrum analysis equipment developed by the space industry to analyze radio frequencies.

Our answer to TIM is a circuit design that ensures the widest bandwidth and the lowest obtainable THD *before* negative feedback is applied. The Marantz 170DC Stereo Power Amplifier (the 1152DC, 1180DC and 1122DC also use this circuitry), for instance, needs only 1/100th (−40 dB) the amount of negative feedback commonly required by other amplifiers to yield the same low total harmonic distortion figures.

Incredibly, Marantz amplifiers with low TIM design can deliver flat frequency response from 0 Hz to 20 kHz *without* the use of negative feedback. And this same circuit design provides the optimum slew rate for minimum TIM and maximum reliability.

Result: Marantz reduces TIM to an inaudible level, which means you get clear, clean sound from all your records and tapes. Think of Marantz with low TIM as a window to the original performance.

If you truly want the best reproduction of musical sound available anywhere—and are willing to spend a little more to get it—then go for it. Go for Marantz.

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*The maximum change of voltage per unit time. Prices and models subject to change without notice. Your Marantz dealer has the full line of Marantz amplifiers. Look for him in the Yellow Pages.

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"Ingenuity of design can be fascinating for its own sake, but when it results in a product of demonstrable excellence, as with this tape recorder, one can only applaud..."

The review is from *Modern Recording*. The tape deck is Technics RS-1500US. And the ingenuity of design that *Modern Recording* and *Audio* have praised in recent issues is Technics' advanced "Isolated Loop" tape transport with a quartz-locked, phase-control, direct-drive capstan.

By isolating the tape from external influences, Technics has minimized tape tension to an unprecedented 80gms. Eliminating virtually all signal dropout. While reducing modulation and wow and flutter to a point where conventional laboratory measurement is seriously challenged. A considerable achievement when you realize Technics RS-1500US is priced substantially below its professional counterpart. $5,500 below.

Electronically, too. Technics has provided the ultimate in professional control and performance. A separate microphone amplifier. Record amplifier. Mixing amplifier. And three-way bias/equalization. While IC full-logic function controls permit absolute freedom in switching modes.

Compare specifications and prices. Then you'll realize there's no comparison. TRACK SYSTEM: 2-track, 2-channel recording, playback and erase. 4-track, 2-channel playback. FREQ. RESPONSE: 30-30,000Hz, ± 3dB (−10dB rec. level) at 15ips. WOW & FLUTTER: 0.018% WRMS at 15ips. S/N RATIO: 60dB (NAB weighted) at 15ips. SEPARATION: Greater than 50dB. RISE TIME: 0.7 secs. SPEED DEVIATION: ± 0.1% with 1.0 or 1.5mil tape at 15 ips. SPEED FLUCTUATION: 0.05% with 1.0 or 1.5mil tape at 15ips. PITCH CONTROL: ± 6%. SUGGESTED RETAIL PRICE: $1,500.*

Technics RS-1500US. A rare combination of audio technology. A new standard of audio excellence.

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